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KANSAS CITY

REVIEW OF SCIENCE AND INDUSTRY,

A MONTHLY RECORD OF PROGRESS IN

SCIENCE, MECHANIC ARTS AND LITERATURE.

VOL. VIII. FEBRUARY, 1885. NO. 10.

ENGINEERING.

KANSAS CITY CABLE RAILWAY.

There are now two cities in this country that have cable railways in successful operation, and very soon three others will be added to the list, New York, Philadelphia and Kansas City. The latter city can claim the first duplicate cable railway, the others having but one cable in the tunnel beneath the street for propelling cars. The distinction between a single and double cable in cable railways is what their respective names imply. In the ordinary cable railway, or single cable road, when accidents occur to the cable, such as loosened strands, broken wires or the cable is otherwise injured so as to affect its strength, to repair these injuries it becomes necessary to stop the operation of the road, thus causing a cessation of business which means a very great loss to the company, or which may be prevented only by continuing to use the fractured cable until the hour of stopping at midnight, which would cause still greater injury and perhaps ruin to the cable for further use.

In Chicago when serious accidents occur, the horses used on other lines owned by the company are pressed into service and made to haul the cars. Horses would be of little use pulling cars along the road in Kansas City, as the grades are so excessively steep that it would be impossible to ascend many of them. Should an accident occur, the public would have to wait until the repairing had been done but for the additional cable and machinery that is at all times ready for use at a moment's notice. The change from one cable to the other requires but very little time, and the travel is not interrupted. The duplicate

road has a duplication of machinery throughout. Besides the cables there are two carrying pulleys side by side that support the cable in every pulley-pit, which are thirty-five feet apart along the road; at the extreme ends of the railway, where in the ordinary cable road there is one sheave twelve feet in diameter, in the duplicate road there are two. This duplication is still more extensive in that two independent sets of driving machinery are provided in the engine-house, also engines, boilers, etc.; in fact, the provision made in the way of machinery is sufficient to build another and independent road; thus the cost is very considerably greater than in the case of a single cable railway.

There is probably no cable railway in the country, that in constructing presented so many difficult features to be overcome as the Kansas City road. The wrought-iron elevated structure from Union Avenue to the top of the bluff does not represent all the work done at this end of the road. At Union Avenue large and massive brick foundations were built pyramidal in shape. Old sewers were encountered requiring special provision to overcome these unexpected obstacles. At the bluff very serious difficulties presented themselves. In locating the foundations for the wrought-iron supports for the viaduct it was discovered that a local movement in limestone ledge was taking place. A great portion of earth and loose rock deposited at the base of the bluff was removed, exposing the rock ledge in question five feet in thickness, underneath which was a stratum of soapstone and bituminous shale eighteen feet in depth, which disintegrated rapidly and thus allowed the rock ledge above to fall in large fragments to the base of the bluff. The rock ledge was cleared of earth and other materials, and all the cracks or fissures located, which were then thoroughly cleaned out and filled with liquid cement grout made from German Portland cement. When the cement had set it excluded all water from springs and surface drainage from the base of the rock, which before served as a lubricant to the moving ledge. The shale and soapstone were further protected by building a stone wall in front of the vertical face of the stratum, close to it; the space between the wall and shale was then filled with concrete and cement grout, thus excluding air and water from the exposed face of shale; the rock ledge was thus made solid and permanent, no further movement having been discovered. The process of disintegration of the shale was watched with considerable interest. It was noticed that so long as the shale contained some moisture, or the water was allowed to saturate the surface, disintegration was retarded, but when the sun caused the shale to become dried and warm, the absorbed air seemed to expand, thus throwing off small particles of shale, which would have continued until the whole ledge had fallen but for the protecting wall and the concrete excluding the air.

The wrought-iron viaduct will, when completed, present a very interesting piece of work. The incline down the bluff is eighteen and three-tenths feet in 100 feet and commences at the west line of Jefferson Street with an elevation of 191 feet and descends westwardly, at the rate mentioned, to the center of the main span across the Union Depot yards, the length of which span, from end-pin to end-pin, is 186 feet. The incline commencing in the center of this span,

and ascending with the rate mentioned, caused a curious modification in the design of this bridge from ordinary bridges. The end posts were made to incline so as to cover two panel lengths of the bridge, thus providing sufficient clearance between the portal bracing and top of car, which could not have been secured had only one panel length been covered by the end post as is usual.

From the centre of this span westward to Union Avenue, the tracks are level, beginning at this point to ascend at the rate of two feet in one hundred to and by the waiting station. The waiting station is quite an ornament of its kind. Stairways descend to either sidewalk of Union Avenue, and are covered and protected from the weather. The roof of the main waiting room projects over the platform on all sides, and is covered with slate. A passenger wishing to take a train up the incline to Main street pays his fare to the agent, who gives a ticket in return, which is collected on the train. He passes through the waiting-room to the train. Passengers coming from the trains pass to the passage-way on either side the building, through the gates to the stairways. The trusses across Union Avenue are sixty-five feet in length and eight feet in depth, and three in number, that support the waiting-room and tracks, which trusses are in turn supported by wrought-iron columns, three on each side the Avenue. These columns are inserted into heavy cast-iron shoes or bases, extending into the casting about two feet. The space between the cast socket and column was filled with cement grout and is now equal to rock in hardness. There are two large sheaves, twelve feet in diameter, over the Avenue, supported between the girders, weighing four thousand pounds each. The main bridge span at Union Avenue is supported by two wrought-iron columns, one under the end shoe of each truss. The distance from the railway tracks below the bridge to the floor is twenty-three feet, and the distance from the floor of the bridge to the upper chord or top of truss, is twenty-six feet. The iron work at this end of the road is composed of eleven spans and they have the following lengths, commencing at Union Avenue: 65 feet, 185 feet, 67 feet, 29 feet, 45 feet, 46 feet, 47 feet, 46 feet, 46 feet, 47 feet, 47 feet. At the end of the last span the cable leaves the open work of the viaduct and enters the concrete subway below the street. The rails of the tracks on the viaduct at one point are about fifty feet above the surface of the ground below. The railway is double-track throughout. There are several steep grades on the line, but none greater than the viaduct grade. There are two curves, both at street intersections, at right angles to each other. A special and independent sewer has been constructed from one end of the road to the other, between the tracks, which connects with the regular city sewers at every street crossing. The carrying pulley-pits are made of brick twelve feet by five by five feet in depth, extending under both tracks in its longest dimensions. They are large and spacious. Two cast-iron pulley frames are arranged at each side of the pit corresponding with each track. Communication is had with the pit by means of a heavy trap door between the tracks.

The cable in passing around the curves at Grand Avenue occasions great resistance. The constructions at the curves consist of a series of horizontal

conical pulleys, there being three independent pulleys on each shaft, which constitute a set. The lower one is a large conical pulley having a groove at its base in which the idle cable rests, the next above this is an ordinary horizontal grooved pulley in which the moving cable rides. The next and upper pulley of the set is a plain pulley with a smooth rim against which the grip rests and by which it is guided around the curve. The cable passes from the engine-house to the sub-way below the street and under the south track, thence to Woodland Avenue, around twelve-foot end-sheaves, thence into the sub-way below the north track to Union Avenue, around the twelve-foot sheaves over Union Avenue, and thence to engine-house, around the driving drums and thence to the tension-car wheel, or sheave.

The grip-cars are radically changed from those in use on other roads, in that the grip is operated from the end of the car instead of in the centre, consequently the gripping attachments occupy very little room in the car. A complete cab is provided at each end of the car in which the grip-man is stationed and operates his grip without being interfered with by passengers.

The grip consists of three parts—the upper or crank part, the middle or shank, and the lower or jaws. The upper is made from cast-steel, and so constructed as to embody great strength; the crank and shaft giving motion to the jaw of the grip are connected at one side, this part with the levers of the grip-wheel in the cab, which crank is also connected with the central and moving part of the shank, which has a vertical motion; the moving part of the shank is also connected with the movable and horizontal upper jaw of the grip, the shank being made from rolled-steel and the jaw of cast-steel lined with brass, reducing the wear on the cable to a minimum. The lower jaw of the grip is stationary, having two rollers placed vertically at each end of the jaw. When it is desired to start a car the grip-wheel in the cab is turned to the right, which forces the movable upper jaw (seventeen inches long) down on the cable resting on or rolling over the pulleys in the lower jaw of the grip; the pressure forces the rollers down a limited distance with the cable; as they are supported by flexible journals, the brass in the grip takes hold of the cable under the pressure of the grip-wheel and the car moves. If it is desired to stop the car, the grip-wheel is turned to the left, thus raising the movable upper jaw from the cable. The pressure being released, the small pulleys in the lower jaw spring upward slightly and support the cable, revolving at the same time, and while the car is thus stayed, receiving or discharging passengers, the cable continues to move through the grip between the jaws supported by the pulleys referred to. It does not matter how often stops are made, the cable never leaves its position between the grip's jaws—it is either gripped by the jaws or riding on the pulleys in the lower jaws. The cable is, however, conducted out of the grip when it is necessary to change the car from one track to another, and in passing over the vault on the south track at the engine-house—there being no cable at this point, as it is conducted into the engine-house too far below the street for the grip to reach—the cars are carried

over this distance, which amounts to forty feet, by momentum acquired from the cable before reaching the vault. This occurs on the south track only.

The cable is one and one-quarter inches in diameter, made from Swedish iron wire. It is capable of resisting a strain of thirty tons. There is a total length in both cables of forty-four thousand feet. It is expected that this cable will have to be replaced within eighteen months from the opening of the road.

Many people have been at a loss to know how the cable is prevented from impinging against the upper side of the tube or tunnel below the street in the depressions along the line, and at points where grades change from a level to a comparatively steep grade. It must be remembered that the cable is very much heavier than a string, its weight being two and a half pounds per lineal foot. When the ordinary tension is on the cable and an average number of grips with their loaded cars attached are being propelled by it, the deflection between the carrying-pulleys, which are thirty-five feet apart, is about two inches. It would be impossible with any power to cause the cable to assume a straight line from one hill to the other, and before the *sag* or deflection could be gotten out, it would break in two. The cable leaves the engine-house with a strain of about one ton and returns to it with about five tons (approximately), doing its maximum work, and the total weight of one cable is about twenty-eight tons, Where it is necessary at the depressions referred to depression-pulleys are placed which hold the cable down, and when the grip passes the cable is pressed down six inches below these pulleys; thus the grip avoids contact with them.

The maximum grades on various roads are as follows:

Clay Street, San Francisco	. . . . .	16 feet in	100 feet.
California St., "	. . . . .	18 "	100 "
Suter St., "	. . . . .	8.7 "	100 "
Geary St., "	. . . . .	9.8 "	100 "
Ninth St, Kansas City	. . . . .	18.3 "	100 "
Chicago City, State St	. . . . .	(about level.)	

The power developed in operating cable railways is usually proportioned as follows:

For moving cable	. . . . .	51 per cent.
For moving cars	. . . . .	46 "
For moving passengers	. . . . .	3 "

The power-station or engine-house is located at the corner of 9th and Washington Streets, and has a frontage on the latter street of ninety feet and on the former of 144 feet, two stories and basement. The east room is the boiler-room, and is separated from the engine-room by a brick partition wall; the floor is thirty-two feet below the street grade. One battery of boilers, after the Ferminicle patent, twenty feet in height, occupying a floor space of twelve feet by twenty feet, have their fire fronts facing 9th Street. The boiler settings are especially attractive, being laid up with Philadelphia pressed brick, with a bold projecting

cornice. In the use of these boilers there is no danger from disastrous explosions, as is the case in the use of ordinary tubular boilers. At the base on either side and a little below the grate-level are two large plate-iron mud-drums, the upper sides of which are framed with a horizontal plate, into which the water-tubes are expanded; the tubes are sixteen feet long and three and a half inches in diameter, and are placed in an inclined position, the ends being expanded into the lower horizontal plates of the upper water drums. There are two of these drums in each boiler corresponding with the lower mud-drums, the tubes in these drums incline towards each other as they extend upward to the water-drums above; above these drums the steam-drum is located, connected with the upper drums referred to by means of two wrought-iron legs six inches in diameter. The water circulates through the tubes, the heated gases passing around and about them. In the case of low water there is no danger of explosion save from the three and a half inch water-tubes, which would result in no serious damage should any explode.

Immediately back of these boilers is located the smoke-stack, and south of this again is another battery of boilers. The smoke-stack pedestal is eighteen feet square, and the total height of the stack 150 feet above the boiler-room floor, the flue is five feet in diameter, having an iron ladder fixed at one side of the flue from the base to the top of stack. Directly west of the stack and against the wall, is arranged a large heater with pumps and other necessary parts. The heater containing water has a height of twenty feet and is fifty inches in diameter, having inverted (∩) U-shaped brass tubes. On either side the heater are Worthington Duplex Pumps, each having a capacity of 8,000 gallons per hour. The exhaust steam-pipe from the engines conducts the steam to the heater, which then passes through the inverted U-shaped brass tubes in the water in the heater, thence by the exhaust-pipe out of the building.

It will be seen that in this, as in all heaters, the steam after having performed all the work required of it in the engines in turning the machinery, is conducted through the heater, thus heating the feed water to a temperature of about 280°; when it is forced by the pumps into the boilers. It is generally claimed that fifteen per cent of fuel is saved by using a good heater over the practice of forcing cold water into the boilers. The total boiler capacity equals six hundred horse power.

The engine-room, which is twenty feet above the floor of the boiler-room, has the appearance of some large pumping-station. There seems at first glance to be a confusion of large drums and gear wheels which, upon closer examination, assume right positions and perform each their respective work. To those expert in mechanical construction it presents a very complete and well arranged picture of accurate designing, nicely proportioned parts, and upon the whole a model plant for the purposes for which it was designed. There are two large automatic cut-off engines quite near the door through which you pass in entering from the boiler-room. The cylinders are 24x48 inches. The engines throughout are highly finished and were built by William Wright, of Newburgh, New York. In place of the ordinary crank, large and highly-polished circular discs are arranged,

which add much to the engines. The engines combined are equal to five hundred horse power.

The engines are about twenty feet apart, having a common shaft thirteen and a half inches in diameter. On the end of the shaft nearest the east engine the large driving-wheel is fixed; it is eighteen feet in diameter, weighing 34,500 pounds. A very heavy and substantial pillar-block supports the shaft between the fly-wheel and the large gear on engine-shaft. This gear has an eighteen-inch face, and is geared into a large gear ten feet in diameter, keyed on the main-line shaft of driving machinery. A very heavy cast-iron girder-frame surrounds the gear referred to. The main-line shaft extends westward across to the girder-frame of driving machinery. This frame entirely surrounds the driving machinery and is eighteen inches in depth and seventeen inches across the upper face. Between the two outside parts of the girder-frame there is arranged a central piece running north and parallel with the outside frame. On each of these three parts of the girder-bed or frame of the machinery, and supporting the main-line shaft, are heavily proportioned pillar blocks. Next the two outside pillar blocks the five-foot gears of the machinery are keyed on a sleeve on the main shaft, which shaft revolves in the sleeve, each of which have a sleeve arranged on their inward side. In these sleeves eight steel circular plates are permanently fixed. Another sleeve is keyed on to the main shaft, which also has eight circular steel plates arranged which revolve with the shaft, but which are worked laterally on a key in the shaft. When the sleeve is moved inward with its steel plates, the plates take up against the steel plates in the sleeve on the gear, causing frictional contact, which is gradual but positive, and when the plates are brought together with sufficient pressure the gear revolves with the main driving-shaft. These gears are connected with a series of gears, which cause the two driving drums twelve feet in diameter of each set of driving machinery, around which the cable passes, to revolve. The central piece of girder frame separates the two sets of machinery, either of which is set in motion or deprived of motion by means of the lever connected with their respective clutches described above. These clutches are known as the Weston Clutch and are the largest of the kind applied to this class of machinery.

When accidents occur to the cable and it is desired to repair it, the clutch belonging to that particular set of machinery is released, and the other is forced against the gear plates of the other set of machinery; thus the other cable is set in motion, doing the work of the injured one until it is repaired. The injured cable is then, by means of auxiliary engines, slowly led into the engine-room where the repairing is done.

These auxiliary engines, especially designed for this purpose, were built by the New York Steam Engine Company. The driving machinery was made by Poole & Hunt, Baltimore, who have a national reputation for manufacturing the finest gears and machinery of this character.

Back of each set of driving machinery there is a track built which extends five feet above the floor of the engine-room, and supported by a series of brick

arches. Upon this track a car moves back and forth, moved back by means of heavy weights in a pit at the back part of the building connected with the car by means of a cable over a vertical pulley at the pit, moving forward as the increased tension on the cable in the street demands, caused by additional cars using the cable. There is arranged also in the center of this tension-car a large twelve-foot sheave which constantly revolves as the cable passes around it, in going from the driving-drum to the sheave and out into the street again. The gauge of the tension-car track is three feet. In front of the engine-house on 9th Street a very large vault is made under the street; the roadway at this point is carried by iron columns. This vault has six large twelve-foot sheaves arranged in it, each of which weighs 4,000 pounds; these are used for directing or guiding the cables in to the engine-house.

The room next west of the engine-room is arranged as a machine shop; it is large and provided with such tools as work of this kind requires.

The 9th and Washington Street floor is used as a storage-room for cars, in one corner of which is provided a very complete wash-room for cars, heated in winter with steam radiators, and also provided with hot water.

The upper floor is used as a paint and repair shop, except that portion partitioned off for offices. These offices are all finished with Southern pine, there being in all six rooms; namely, conductors', superintendent's, cashier's, directors', and civil engineer's office.

The total length of this road, as now built, is two and one-quarter miles. Next summer the road will be extended eastward one mile on Independence Avenue, and one mile on 9th Street. Mr. Robert Gillham, C. E., chief engineer of the company, has his plans of these extensions nearly completed. Plans are also being prepared by Mr. Gillham, who is also chief engineer for the Inter-State Rapid Transit Company, who are about building an elevated cable railway from Kansas City to Wyandotte. The total length of this road, including the proposed surface cable railway through Wyandotte, will be three miles, making a total length of double track, when these extensions are completed, of seven and one-quarter miles, all of which road will be operated by the machinery and the cable that operates the Kansas City Cable Road, described above.

There has been very little reliable information gathered regarding the economy and the power required under different conditions of loading of cable, to operate these roads. While it is true that cable railways have been in operation in San Francisco for several years, no scientific records or tests have been made; thus the results are not very well determined.

Mr. Gillham has provided means of testing the capacity of boilers, power of engines, evaporation of water per pound of coal, power required to move cable, machinery and cars; also to test power required in ascending the various grades, and to test the tension on cable under all conditions of loading. The information gathered from careful tests of this character will be of value to the engineering profession.

ANCIENT AND MODERN ENGINEERING AND ARCHITECTURE.

DR. R. WOOD BROWN.

The remark, "there is nothing under the Sun," is more axiomatic than the casual reader believes. We think that this is a very progressive age and that our generation stands pre-eminent in civilization—is the highest known. This is so, but to state that we, in this age, are immeasurably superior to the ancients is, we think, incorrect. Our aim is not to prove our century inferior to the past ones, rather it is to present historical facts which will indicate that mordern architectural and engineering works are merely reproductions of those of the ancients, though sometimes larger and more speedily erected, owing to better facilities.

The works of long ago compare very favorably with those of the present, and in some instances excel anything of our own time. Hardening copper for tools is one of the lost arts; we cannot manufacture the Damascus blade, nor do do we know by what means the pyramids were erected. There are very few (if any) streets like one in Cordova founded 152 B. C. It was perfectly straight, ten miles long and illuminated by public lamps. Paris, which is said to be the best lighted city in the world, cannot surpass this wonderful street. Cordova was not without rivals. Granada, founded before Augustus; Seville in its prime 590 B. C.; Toledo taken by Maximus Flavius 193 B. C., vied with Cordova with its 200,000 houses and 1,000,000 inhabitants. This city of Cordova may not be a fair comparison, as its decay commenced when conquered by Ferdinand III. of Castile in A. D. 1236. Modern cities surpass the ancient in number rather than in magnificence.

A slight acquaintance with archæology is sufficient to show us that the Statue of Liberty Enlightening the World is a duplicate in principle of the Colossus of Rhodes. The former is to be erected upon Bedloe's Island in New York Harbor, in honor of fraternity between France and the United States. It is of copper and the ascent to the head is made by inner stair cases. The right arm is extended, grasping a torch which will illuminate the harbor by electricity. The total height is 328 feet 11 inches, pedestal 177 feet 9 inches, leaving 151 feet 2 inches for the statue. This work of art was fabricated in France under the supervision of its projector, Bartholdi, who, in all probability took his idea from the Colossus of Rhodes, which was also erected upon an island, the Rhodus, in the Mediterranean Sea twenty miles from Lycia on the south coast of Asia. This Colossus was of brass, and erected 300 B. C. in honor of Apollo. Historians tell us that the height was 125 feet, "with legs distended on two moles which fromed the entrance of the harbor," said moles supposed to have been twenty feet apart, and ships sailed under the body on entering the port. The statue was hollow and the legs were lined with large stones to counterbalance the weight. This Colossus was the workmanship of Chares a pupil of Lysippus, a celebrated sculptor of Greece.

The Colossus of Rhodes was thrown down by an earthquake sixty years after erection. The brass made 900 camel-loads, or 720,000 pounds.

The Washington Monument, is considered a grand work, but the work of putting a new foundation under the old one was far more wonderful than the building of the obelisk itself. (See Kansas City REVIEW OF SCIENCE AND INDUSTRY, January, 1885, page 501). This monument presents a smooth exterior and is 555 feet in height; was commenced more than thirty-six years ago and finished under Colonel Thomas Lincoln Casey, chief engineer and architect, December 6, 1884. This pile of stone is hollow and capped by marble with a conical apex of aluminum. The Pharos of Alexandria was 450 feet high and built upon an island. Alexander the Great gave his order for this structure 332 B. C. to a Macedonian architect, Dinocrates by name, who also connected the island with the mainland by an earth wall. This light-house differed from the Washington Monument in being highly ornamented, the stone was finely carved, columns and balustrades worked in the finest marble embellished the exterior. It was built in several stories, tapering towards the top. The ground floor and the two next were hexagonal; the next square, with towers at each corner; the fifth to the top was round, with an exteral winding staircase. The extreme top was open so that sailors could see its night beacons. The Pharos at Alexandria was a work of art, a credit to Alexander who commenced, and to Ptolemy Philadelphus who finished it. The Americans have built the highest structure known to man, but it is barren of all art. There is quite a difference between building a lighthouse with carved marble on an island, and erecting huge stones perfectly smooth by machinery, inland, even to the height of 555 feet.

Both ancient and modern engineers and architects considered height as a great objective point. The great Pyramid is 478 feet. Cologne Cathedral is 510 feet. Rouen Cathedral 490 feet. The statue of San Carlo Borromeo, at Arona, erected in 1697 was 66 feet high and the pedestal 40 feet. A marble statue of Nero was said to be 120 feet high. The walls of Babylon were 378 feet high, also 93 feet 4 inches thick and in compass 60 miles. Herodotus, who was at Babylon, gives these figures; others give the height 50 feet as they were after the time of Darius Hystaspes, who pulled them down to that height, that he might conquer the city again more easily, if necessary. The Chinese wall was much longer, being 1,250 miles, but very much inferior in width and height; only 20 feet high, 25 feet wide at the base and 15 feet at the top; about one-third of the wall of China is dirt and rubbish, the rest being masonry, and it dates back to 220 B. C.

The Hanging Gardens of Babylon were built by Nebuchadnezzar to gratify his wife Amytis. The gardens were over 400 feet square, built terrace above terrace until they were 27 feet higher than the walls, or 400 feet. The top was sustained by a series of arches one above the other and each terrace was bound by a solid wall 22 feet thick. On the top arches were first laid flat stones 16 feet by 4, over these weeds and bitumen; then two rows of cemented brick covered

by sheet lead, upon which was laid earth sufficiently thick to nourish large trees. The gardens were filled with the blooming plants and shrubs which were admired by Queen Amytis in her native Media. The different terraces and groves contained fountains, parterres, seats and banqueting rooms; in fact all the splendor and magnificence of eastern art seem to have been lavished upon these gardens by King Nebuchadnezzar in order that his Median bride should be happy in her new home. Pen cannot picture the grandeur of the conception or the perfection of the execution of these gardens, which have been and are the wonder of all ages. The greatest hanging structure now in existence is the Brooklyn suspension bridge, costing $15,000,000. The whole length is 3 475 feet, and it connects New York and Brooklyn by a clear span of 1,595 feet. It is 135 feet above low-water mark and 85 feet broad, it has also two platforms, one above the other. The piers are stone masonry, hollow and sunk below the surface by means of caissons. As the details of this work are formidable it is sufficient to say that it is the greatest engineering feat known. John Roebling was the engineer.

One of the mysteries handed down to us is the manner in which the ancients manipulated those immense stones. Take the obelisk of Luxor, which stands sentinel over the Place de la Concord, in Paris, seventy-three feet in length. Long-continued manual labor could quarry it, but by what means it was conveyed to Luxor is still hypothetical; and the stones of the Pyramids, not one of which is less than thirty feet long by five thick, how could they be hoisted up 478 feet, or rather, how were they, and by what means were these great blocks of granite transported from the quarry at Syene to the delta of the Nile, a land journey of six hundred or a voyage of seven hundred miles? Egyptologists have surmised many ways by which the Pyramids were built, but none of them seem satisfactory. No representations of derricks or hoisting machines have been bequeathed to us. Some writers say that the stones were raised by machines from step to step, others tell us that skids were used, still others that the external covering was laid from the top to bottom. The great Pyramid Cheops covers at base about 550,000 square feet and rears itself 478 feet. The first step is nearly four feet eight inches high, the top one one foot eight inches. Mathematics were known in that day, as its angle was perfect at all sides 51° 50′, also each stone was accurately fitted to another. Notwithstanding the difficulty in finishing granite the stones of this royal tomb were finely polished. Chronologists differ as to the date of the reign of Cheops, the latest date given being 2123 B. C. Herodotus says that he "was informed by the priests of Memphis that the great Pyramid was built by Cheops, that 100,000 men were twenty years in building it, and that the body of the king was placed in a room in the bottom of the Pyramid." No king ever had a mausoleum so beautifully magnificent; beautiful in its simplicity, magnificent in its proportions. The Pyramid of Aphren is 684 feet square and 456 feet high. The Pyramid of Mycerinius is 330 feet at base and 174 feet high. There were many other pyramids built, but to all of them we can only say "the eternal pyramids—the mystery of the past—the enigma of the present—and the enduring for the future ages of this world."

We have never felt the feebleness of our descriptive powers so keenly as in the preparation of this paper. We have seen some of the works of the past, and their impressions can never be obliterated from our mind. We have seen the magnificent Cathedral in Milan, have seen the sun's rays reflected from its white marble, towering up 358 feet; we have watched day after day the light and shadow creep over its 10,000 statues, 1,500 bas reliefs, and its 136 spires. We have wandered over its variegated marble floor 486 feet long and 288 feet wide, and have climbed wearily to the top, yet we have no power of description—no delineation can convey our ideas adequate to the effect in viewing this stupendous church, begun in 1387, March 15th, and yet unfinished, costing so far $110,000,000. The Temple of Diana, at Ephesus, has been graphically described by archæologists and we cannot do better than to gather bits of their brilliant pen pictures. The original object of worship in Ephesus was a small statue of Diana made of ebony and believed in those days to have been sent down from heaven by Jupiter. A temple was erected to contain this image and completed during the reign of Servius Tullius 570 B. C. This temple was said to have been destroyed by fire. A second one was commenced about 540 B. C. exceeding the first in splendor, and this was partially burned on the day Socrates drank the hemlock 400 B. C. After having been restored with greater grandeur it was again partially burned 356 B. C. on the night Alexander the Great was born. Materials saved were sold, women gave up their jewelry, and contributions were sent from all parts of Asia, amounting to an immense treasure, and thus the Temple of Diana was restored in all its magnificence. Pliny says "that to secure the foundations of the conduits and sewers which were to support this structure, there were laid beds of charcoal, well rammed; over them wool; and that 220 years elapsed before this grand temple was completed." It was 425 feet in length and 220 in breadth, supported by 127 marble Ionic columns sixty feet high, of which thirty-six were richly sculptured and fhe rest highly polished. Each column was a gift of a king. The building and courts were encompassed with strong walls, there was a court on each side of the temple which was built upon a series of narrow arches one within another. The site being a morass, the foundations were said to have cost more than the superstructure. This magnificent work of art is no more, but if we should visit Constantinople we would find the Church of St. Sophia raised upon some of these columns given by kings to the goddess Diana. Justinian also filled Byzantium with statues from Ephesus.

One thing the ancients did not attempt; at least there is no record of their building self-supporting domes prior to the church of St. Sophia, in Constantinople, originally built by Constantine, destroyed by fire, and rebuilt by Justinian. The dome is 175 feet high. St. Paul's, London, commenced in 1675 and finished in 1710, has a dome 145 feet in diameter, and 365 feet from the ground. St. Peter's has the largest and highest dome known. This beautiful pile was commenced in A. D. 1450, and finished three and a half centuries after. The dome is 405 feet from the pavement and 193 feet in diameter. The domes of the churches of St. Genevieve and Invalides, Paris, are also self-supporting.

Not even Dinocrates, who built Alexandria and the Pharos, also the Temple of Diana, attempted the difficult engineering feat of self-supporting domes. In constructing the Pyramids mathematics were known, consequently it was not ignorance which prevented the ancients from worshiping under a self-supporting vault.

The sewers of Paris are great works of skill, large enough to float inspection-boats, but they do not surpass very much the Maxima Cloaca of Rome, thirteen feet broad and thirteen feet high, built by Tarquinius Priscus, 616 B. C. Athens had sewers which drained into the Saronica gulf. Babylonian sewers drained its marshes into the Euphrates. Modern age has simply copied from the ancient. The principle is the same now as when the Alexandrian architect wished to build a temple to Arsinoe, in which he intended to suspend her statue by means of a lodestone. The only thing modern sanitation can claim over the ancient is sewers greater in length and number, owing to the greater needs.

Of aqueducts, the Croton of New York claims the honor of being the finest of our age. It is forty-two miles long and thirty-three from Croton lake to Harlem river. Lisbon aqueduct is twelve miles long; the one which carries water to Paris 110 miles. Ancient Rome had fourteen aqueducts. Three of these supply modern Rome, Aqua Virgo, about eleven and a half miles, built by Agrippa, to supply his baths. Aqua Claudia, forty-five miles long, and Aqua Trajana, twenty-three miles, built to supply inland basins for spectacular sea fights. Constantinople had its aqueduct of Pyrgos fifteen miles long. The aqueduct supplying Athens had perpendicular pipes of clay or lead every 240 feet or so, leading up to the surface; by this contrivance light and air were admitted to the water. Eupalinus tunneled through a hill at Samos eight feet high, eight feet broad, and four thousand two hundred feet long, with an accurately-reckoned declivity; also a channel at the bottom, three feet square, to carry the water, which was thereby aerated. Duplication of tunneling on a greater scale is found in Mt. Cenis eight miles long, double tracks. It is twenty-five feet wide at the base and twenty-four feet high. St. Gothard is nine and a half miles long. Hoosac is 25,040 feet, and Sutro 3.84 miles long. The last clearly parallels the Samos tunnel, being used to carry water from a mine. Some writers say that the Euphrates was tunneled under, but the statement is vague and bears no authenticity.

The reservoirs of the ancients were not inferior to those of the present time. The expertness of the ancient engineers is attested by the remains extant; they certainly are not buried in the waters of the Lethe. The Pools of Solomon still continue to furnish water to Jerusalem. They are three in number. The upper is 160 feet above the middle one, the latter 248 feet above the lower. The first was supplied by pipes from springs, and, when full emptied into the second and that into the lower one. The water was used for irrigating Solomon's gardens and supplying his temple. The lower pool held about 31,442,425 gallons, the middle about 12,289,912, and the upper one contained 13,778,772—a grand total of 58,511,109 gallons, or nearly six times as much as the Kansas City reservoir, which is estimated at 10,000,000 gallons. These pools were solid rock and

masonry, lined with cement, and had steps leading to the bottom. One historian says that Nebuchadnezzar, wishing to brick the bottom of the Euphrates, which flowed through the center of Babylon, caused a reservoir forty miles square to be dug so as to allow his masons a dry river bed. Another historian writes that Nitocris, a daughter of Nebuchadnezzar, is said to have dug a reservoir 420 stadia in circumference, lined with stone, for the waters of the Euphrates, in order that the river-bed at Babylon should be dry so that she could build piers for a bridge. A stadium being 625 feet, it would make this circumference forty miles. These two reservoirs may be the same, and this shows what discrepancies there are among writers.

The melting snows from the Armenian mountains sometimes caused an overflow of the Euphrates, whereby the city of Babylon and the country surrounding suffered from inundations. It was therefore necessary to drain the country, and to prevent any future trouble two canals were cut west from Bossippa to the river Tigris, which makes these canals about seventy-five miles long. Ancient Greek authors attribute this work to the ruler who made the greatest city of ancient times and one never excelled in any age—Nebuchadnezzar. There are many canals now of modern engineering, but few, if any, constructed to drain and to receive waters from overflowing rivers. The longest canal is the Erie, in New York State, 350½ miles long and 70 feet wide, finished in 1862. The largest canal is the Suez, authorized by Said Pasha in 1854, built by M. Ferdinand de Lesseps, and finished, or rather, officially opened in 1871. It is 100 miles long, of which 25 miles are lakes. Its width varies from 325 to 197 feet at the top, and is about 70 feet wide at the bottom; the depth varies from 30 to 85 feet. The Erie canal entire cost nearly $46,000,000, while the capital stock of the Suez company was $60,000,000. The United States leads all other nations in number of canals—forty-four altogether.

The length of this paper forbids our writing further, although the archæological fields are blooming with undescribed beauties of art. Many more comparisons could be made which would place the modern age in an unenviable position. Readers who have been our companions so far will notice many so-called errors, but when it is borne in mind the large number of historians and archæologists, also the difficulty of deciphering the writings of those whose sarcophagi have been violated, it will be apparent that dates and measurements, at the best, are merely approximate.

KANSAS CITY, MO., January 21, 1885.

UNDERGROUND WIRES.

Representative Bond of St. Louis has introduced in the Missouri Legislature a bill providing for the removal of all telegraph, telephone and electric light wires from poles and buildings to channels under ground.

It provides that no person or persons, or company, or corporation shall be

allowed to erect or maintain on telegraph poles, piers, abutments, wires or other fixtures upon, along or across any of the public roads, streets, and alleys of any city having a population of over 100,000 souls. The companies will be given one year after the passage of the act to take down their poles and wires, the penalty for the maintenance of such after that time to be the payment of $1,000 a day into the State Treasury until the poles and wires have been taken down. Mr. Bond says that wires are now being put under ground in Chicago, as they have been in New York and Philadelphia, and that his bill will be similar to the one passed by the New York Legislature, and decided as valid by the Supreme Court of that State.

We find in the *Globe-Democrat* the following article, which doubtless expresses the popular feeling upon this subject:

New York has a law ordering that all telegraph, telephone and electric light wires in New York City and Brooklyn shall be put under ground by the 1st of next November, or else be torn down by the city authorities. The passage of this law last spring filled the managers of the electric companies with consternation, and they have from time to time been loud in their protestations of inability to conform with the order, though professing themselves to be only too anxious to have some feasible method of doing so. The honesty of these declarations receives a severe shock now from two eminent experts in electricity. Prof. Bell, who invented the telephone, not only believes that every city ought to insist upon the burial of telephone wires, but says that the service would thus be greatly inproved; while Sir William Thomson, in an elaborate report upon the telegraph service, affirms as the result of his experiments that "there is no doubt whatever that any amount of traffic could be worked through a system of underground wires at the usual rates of hand sending." Nor, he adds, "is it any more difficult to work lines composed partly of underground and partly suspended wires. The cost of maintaining underground wires would compare favorably with that of aërial lines, though the first expense would of course be vastly greater. But, on the other hand, "underground wires will be almost free from interruptions due to storms or to extremes of heat and cold, whereas aërial lines, however well constructed, must always be subject to injury from wind, snow and extreme cold."

These opinions are worth emphasizing because the subject is being mooted in almost every city of importance in the land, and is everywhere met by the electric companies with the same profession of helplessness. Of the desirability of the change there can hardly be two opinions. The forests of wires which fill many of the streets of every city are not only an offense to the sight, but a source of annoyance and frequently of danger. They present one of the confessed hindrances to the best efficiency of the fire department service, and in the case of electric light the wires are a constant menace to property and life. Cases of death and of the burning of buildings from contact with the electric light wires are not unknown and electricians have testified that this danger is by no means small. A storm which throws the wire to the ground might easily make it an instrument of death; a stream of water from a hose-pipe striking an abraded insulation

might kill a fireman; or a wet flag-pole jutting out from a house might serve as the conductor for a devastating current. In fact, security in the case of the electric light wire, depends upon keeping intact a slight covering that is swayed by every breeze.

The subject is, however, one of indisputable difficulties, particularly in cases where, as in the telephone, single wires are conveyed for considerable distances, and the income from them is of necessity small. To insist that every telephone wire shall be placed underground would, under existing conditions and until this modern luxury is much more generally enjoyed, frequently amount to prohibtion. It is becoming a serious question, too, how far it is advisable to carry the system of underground communications in the streets. What with sewer, water, gas and steam pipes, the streets of many cities are being pretty constantly dug up, to the obstruction and even prevention of the travel which is their principal office. Perhaps the solution of this complex problem may one day be the adoption of a general and uniform system of underground communications, like a common subway which shall contain all the appliances for distributing heat, gas and electricity, and shall be of sufficient size to permit of ready access for additions or repairs. The cost of such a system would, doubtless, be very great, but it would settle the problem once and for all.

GEOLOGY.

THE CRAWFORDSVILLE CRINOIDS.

PROF. D. A. BASSETT.

About thirty-five years ago, the students of Wabash College in their rambles along the bluffs of Sugar Creek, not far from the town of Crawfordsville, were greatly delighted with beautiful little cavities which they discovered in pieces of rock picked up or pulled from the loose shale of the bluff. These cavities resembled moulds of beautiful flowers. There was the impression of a slender stalk, a calyx singularly marked with rows of little dimples, and a corolla of long slender petals with delicate pinnate fringes. These were impressions left in the rocks by fossil crinoids whose decayed remains had been washed away.

As I am informed, the first crinoid found in this locality was picked up by Rev. H. C. Hovey, at the time a student in Wabash College. This specimen, however, differed so much in form and appearance from the beautiful impressions alluded to, that it suggested reptiles rather than lilies, and hence was labelled, "a petrified toad" by this young scientist, who has since won for himself much honors among the caves.

The deposit from which the crinoids were taken, is situated in the bluff on

the right bank of Sugar Creek, one mile north of the city of Crawfordsville, Montgomery County, Indiana. It extends up and down the creek a distance of about thirty rods, cropping out towards the northeast, and pitching under the creek towards the southwest. How far it extends into the bluff is not known, but probably not very far. This small space of four or five acres seems to be the only spot in Montgomery County where these fossils are found, and the only one in the world where they are found in such abundance, and in such favorable conditions for excavating and preparing them for the cabinet. For some reason this seems to have been a favorite locality with these remarkable animals of the carboniferous seas.

Geologically, the beds belong to the Keokuk Group of the sub-carboniferous period, and are composed of argillaceous shale, loose and much broken at the top, but more compact and solidified below. The rock is stratified, and indicates aqueous deposit in quiet waters. In color the strata resemble French gray, or light lead color tinged with blue. The upper strata for several feet have been bleached to a light brown by infiltrations of the surface-water. The strata vary in thickness from one to three feet, and the hardest of them, owing to their shaly character, may be quite easily split into slabs of various thicknesses.

Remains of crinoids and other fossils, decayed and worthless, are found quite abundant at the very summit of the shale, and continue to the depth of fifteen feet. The next twenty feet are almost entirely destitute of fossils of any kind, and the cessation of life above and the beginning of life below are very abrupt. The first crinoids, sufficiently well preserved for cabinet collections, are found at a depth of thirty-five feet from the top of the bluff, and most of this distance the rock must be blasted. Below this point, crinoids have been found at different intervals as far as excavations have been made. They do not occur in all the strata, neither are they uniformly scattered through those in which they do occur. For the most part they seem to have lived in schools, or clusters, sometimes crowded so closely together as to be lying one upon another five or six deep. In a slab measuring three feet by two and a half, taken from one of these clusters, and the matrix so removed as to expose the fossils in their natural position, there were eighty crinoids besides several other fossils of different genera and species. The crinoids with their curious heads, and their long stems crossing and recrossing each other, lay stretched out one above another in every direction. Among the crinoids in these clusters are frequently found mollusks, trilobites, conularia, archimedes, pentremites, ongchasters and protasters, and some others, strangers to the writer.

These clusters usually extend but a few feet, and generally terminate abruptly, and where another such shall be found, is a matter of chance, involving much time and hard labor. An occasional crinoid, usually of larger size and more perfect than usual, may be met with in the intervals between these clusters, but in the intervening spaces between the bearing strata, which vary from one to several feet, we may look in vain for any crinoids fit for the cabinet—nothing but fragments of heads and stems, evidently the work of mollusks.

The crinoids from the Crawfordsville beds are remarkably well preserved. They are evidently lying just where they lived, died and were buried in the ocean ooze thousands of years ago. During all these ages, they have remained undisturbed, so that the finest markings and most delicate tentacles and pinulæ are perfectly preserved. And such is the nature of the matrix in which they are imbedded, that with sufficient care, patience and skill, they may be so removed as to restore the animal with all the parts entire. Such specimens are not only very beautiful, but they also afford the very best opportunity for studying the structure, nature and habits of these animals.

It must not be inferred from what has been said, however, that all the specimens obtained in these beds are perfect. So far from this being the case, probably not more than twenty per cent of the heads found are perfect, while an *entire* crinoid, head, stem and root, of the larger species, is so seldom met with, that the author in all his excavations, extending through several years, has never found but one. That may be seen among the many other rare specimens, in the museum of Wabash College.

For more than two hundred years crinoids have occupied the attention of scientists. During that time they have certainly received their full share of attention. Agassiz tells us that up to his time not less than three hundred and eighty authors had published their investigations upon the crinoids, and that the books printed about these animals would furnish a library in themselves. And to this we may add, that there are many questions connected with the subject still unsettled.

The perplexity concerning the true nature of the crinoid commenced in the sixteenth century. Small, round, flat stones with holes through them, and impressions of little stars upon their sides, excited great curiosity. "What are they?" was the question. The common people called them pulley-stones, and St. Cuthbert's beads, and wore them for ornaments and used them for rosaries. Scientists, puzzled and perplexed, called them *trochites*, from the Latin trochus, a wheel. In process of time, beautiful impressions were found in the rocks, much the same no doubt, as those found by the students of Wabash College along the banks of Sugar Creek. These were supposed to represent fossil plants, and what name more appropriate than *Crinoid*, from the Greek *Krinon*, a lily. In process of time, this idea of the nature of the crinoid was still farther confirmed by the discovery of a single specimen from Porto Rico, "described," as Professor Louis Agassiz tell us, "by the naturalist Gueltard, which was so similar to the fossil lilies of the rocks, that he called it a marine palm."

The French naturalist, Cuvier, was the first to discover the true nature of the crinoid. Careful study of the Trochites, the lilies of the rocks and the marine palm, revealed to him the relation existing between them and the fact that the crinoid was not a plant, but a marine *animal* of the sub-kingdom radiata, and class Echinodermata.

So striking is the resemblance between some species of the crinoid and some kinds of plants, that, while the correctness of Cuvier's deduction is not ques-

tioned, the idea has for a long time prevailed that the crinoid is really two-fold in its nature, animal and vegetable combined, thus constituting a connecting link between the two kingdoms. According to this idea, the crinoid was a marine animal-plant, whose house was in the bottom of the sea, where, with its roots anchored in the mud, or ooze, to some rock, stone or stick, it grew, budded and sent forth branches which developed into young crinoids. Such is the idea advanced by a writer in *Harper's Monthly* for February, 1879. "The true animal plants however," he remarks, "are without doubt crinoids or stone lilies. With them the resemblance is almost perfect, to the minutest particular. They resemble a flower borne upon a stem terminating in an organ called a calyx, which is, properly speaking, the body of the animal. Branches issue from the main stem, which at its base bears a sort of expanding root planted amid the rocks, and capable of growing by itself and nourishing the stem." The same idea has been more elaborately and poetically stated elsewhere.

According to this, the natural position of the crinoid is vertical, its roots buried in the mud and firmly anchored to some solid support. "In this way they lived and grew and flourished like beds of roses or other flowering shrubs. The extremities of the branching stalks budding, bloomed into young crinoids which after a time, having grown somewhat strong, cut loose from the parent stock, and floating off, roamed at pleasure through oceans depths until satisfied with this roving mode of life, and being more perfectly developed, it too settled down as its ancestors had done, and fastened its roots among the rocks, or in the mud, and there grew, and expanded its branches and put forth buds, and bore its crop, and sent out its progeny to assist in peopling the depths of old ocean. Those long stalks enabled the head to sway and move about within a certain distance, and with its long slender arms with their feathered pinulæ to seize the unwary minnow or star-fish or mollusk which happened to stray within its reach."

This is the poetry of science. Very beautiful, and attractive. Such was the crinoid the writer expected to find as he commenced excavations in these Crawfordsville beds eighteen years ago. But those dreams have never been realized. After years of delving and most careful search after what we fully believed to be a reality, we are reluctantly led to the conclusion that whatever may be found in other deposits, no such fossil exists in this. As we have read the description of the crinoid as written by nature herself in these rocks, it differs materially from the fancy sketch above.

We find no evidence of a dual nature in the crinoid—animal and plant combined—a connecting link between the animal and vegetable kingdoms. This idea has no doubt originated in the striking external resemblance of some species of crinoids to certain plants, and especially to the lily. But this resemblance, even in the most striking cases, is only external, while the *internal* structure in every instance is entirely different.

Furthermore this resemblance, instead of being general as many suppose, is really of rare occurrence. Most species of crinoids in their external appearance

would never suggest the idea of a plant, and least of all a lily. The young scientist named his first specimen "a petrified toad," and the resemblance is very striking. He might have named another "a petrified chicken's claw" and he would have had the scientific name in English, and a likeness even more striking than in the first case. Who would ever think of calling the warty *goniasteroidocrinus* with its long flexible stem coiled and knotted like a snake or some great worm, and tapering to a perfect point—who would think of calling this thing a connecting link between the animal and vegetable kingdoms? And how such things as these are to anchor themselves to some stick or stone and maintain an upright position is more than we can imagine. Very many species of crinoids have nothing to resemble a root at the extremity of the stem. And where this resemblance does exist, there is not the least evidence that they served any of the purposes of a regular root.

Of those spreading branches, budding and putting forth young crinoids "to people old ocean," we find not the last evidence. The theory is doubtless a deduction from analogy. The testimony of the rocks upon this point is very meager, but from the best evidence we can find we incline to the belief that these Paleozoic crinoids were oviparous.

Since the days of Cuvier, much time and attention have been given to the study of these animals, especially their structure and classification. In form they present almost an endless variety. Upon this point we quote the beautiful language of Professor Louis Agassiz: "After thirty years' study of these fossil crinoids, I am every day astonished by some new evidence of the ingenuity, the invention, the skill, if I may so speak, shown in varying this single pattern of animal life. * * * They seem like the productions of one who handles his work with an infinite ease and delight, taking pleasure in presenting the same thought under a thousand different aspects. Some new cut of the plates, some slight change in their relative positions is continually varying their outline, from a close cup to an open crown, from the long pear-shaped oval of the calyx in some, to its circular, or square, or pentagonal form in others. An angle that is simple in one projects by a fold of the surface and becomes a fluted column in another; a plate that was smooth but now has here a symmetrical figure upon it drawn in beaded lines; * * * . It would require an endless number of illustrations to give even a faint idea of the variety of these fossil crinoids."

The limits of this article will admit only of a general description of the structure of these animals. The head, which in some species resembles a flower, is really the body of the animal, and consists of a cavity or calyx composed of a number of calcareous plates, joined together in the living subject by membranous attachments. Within this cavity were enclosed all the vital organs. In some instances the vault of this cavity is prolonged into a slender tube varying in length in different species. The cavity of most crinoids is fringed with arms, some simple, others branching, the number varying with the species. These arms are also composed of calcareous plates arranged in single, double or quad-

ruple rows. Some of these much resemble the scales of a chicken's foot, others the braids of a whip lash, others still the rows of kernels upon an ear of corn. These arms contain ambulacral processes which connect with the organs of nutrition within the cavity or calyx. The inner edges of these arms are fringed with pinulæ or filaments resembling the margins of a feather or quill, or with tentacles. Through these delicate organs it is now supposed that the animal absorbed a glutinous substance found at the bottom of the sea, which, passing through the hollow spaces within the arms into the organs of nutrition within the calyx, nourished the animal. This of course is at variance with the idea advanced in both extracts above, and illustrated by a cut in Murchison's Silurian and in some early geologies, which represents a crinoid with its long, slender proboscis thrust into the shell of a mollusk upon which it was supposed to be feeding. But without doubt, this picture, thus explained, reverses the order of nature. The mollusk was feeding upon the crinoid. Various facts confirm us in this opinion.

In the first place it is now quite well established that the proboscis, once regarded as a passage for food, is really an anal tube, and that there is in the Paleozoic crinoids no oral opening through the wall of the calyx except the passages connected with the ambulacral processes of the arms. Furthermore, we have in our possession a number of specimens with mollusks, especially *Platyceras infundibulum* (M. & W.) firmly attached to the crinoids, and in every case the aperture of the mollusk covers the anal opening. In all these cases therefore, the crinoid could not have been feeding upon the mollusk, unless this opening is both anal and oral, as some suppose. If this be the case, and the crinoid is really devouring the mollusk, then we should expect to find the crinoid in a healthy condition in every case, and the mollusk the reverse. Now the fact is that of a large number of specimens of this kind, in every instance the mollusk is in a perfect and healthy condition, while the crinoids, in nearly every instance, are more or less imperfect and decayed. The apparent exceptions are cases in which it is evident that the mollusk became attached to the crinoid only a short time before both perished. It is exceedingly interesting to note the different stages of decay in the crinoid as illustrated in the specimens alluded to. First there is a slight depression of the calyx opposite the anal; then it is cupped more and more. Finally the calyx is completely collapsed, and so the process continues until nothing is left but the plates and rings, which lie scattered about the aperture of the mollusk, which has continued to become more stout and robust throughout the entire process. I have repeatedly found a *Platyceras equilatera* attached to the anal tube of *Actinocrinus indianencis*, and *A. ramulosus, and inclosed within the arms*. At first I congratulated myself upon the discovery of a case in which the crinoid was actually feeding upon the mollusk. Examining the specimen more carefully, I discovered that the proboscis was entirely gone, and the plates were lying about the aperture of the mollusk, and that the aperture was fastened upon the vault and directly over the opening into the cavity. A great number of such specimens as these have convinced the writer that vast

numbers of these animals were destroyed in this way, and that the crinoids did not subsist upon "minnows, or star-fishes, or mollusks that happened to come in their way." Indeed, we must confess that after years of very careful observation we have never yet found a specimen which furnished *satisfactory* evidence as to what the crinoid subsisted upon.

To the head of the crinoid was attached an appendage, which, for want of a better name, we call a stem. This is composed of a series of flat calcareous rings or plates, perforated at the center. The reader will recognize in these plates the Pulley-stones, and St. Cuthbert's Beads already alluded to. The broad surfaces of these rings, in the larger species especially, are striated from the central perforation to the circumference. As the surface of the plates enlarges towards the circumference the striæ bifurcate to keep the intervening spaces all equal. These plates are laid one upon another, the surfaces being so arranged that the striations of the one fit exactly into the little grooves of the other, the sutures around the margins having the appearance of saw-teeth fitted together. By this means the possibility of any rotary movement of the plates upon each other seems to have been effectually prevented. This, however, did not prevent considerable flexibility in the stem, as in the case of the *Goniasteroidocrinus* already alluded to.

So great is the diversity in the exteral margins of these rings, that it is easy to distinguish many species by the appearance of the stems. We feel satisfied that, before a complete and satisfactory classification of these animals can be made, these stems will need to be more thoroughly studied. Endless variety would seem to be the design of nature in the construction of these stems as in the other parts of these animals. And equally interesting is the study of the different construction and markings of this singular appendage.

The growth of the stem seems to have been by successive additions of new plates at the junction with the base of the head. In most species these at first are quite thin, but they increase in thickness as the formation of new plates removed the older ones farther and farther from the point of origin. By this double process, no doubt, the stems were lengthened. These plates were doubtless held together by muscular attachments, and the cavity within filled with animal substance.

Everything seems to indicate that these stems, and the arms as well, were exceedingly fragile, and on this account, it is very difficult to obtain an entire crinoid, or even a head with a long piece of stem attached. No doubt many suppose this is owing to the difficulty of removing the specimens from the quarry without breaking, but such is not the case. The fact is, the crinoids were broken before they were fossilized, even while yet alive. In the large slab already alluded to, containing eighty crinoids, not more than half a dozen were entire, and these were mostly young specimens, or small species. The stems were nearly all broken, having been slipped apart at the joints, leaving stumps of various lengths attached to heads. In removing the matrix from specimens in these large slabs, I have repeatedly found the stems disjointed by too short a

fold in the sinuosities, or by some short turn in the direction of the animal's course in forcing its way through the mud, the parts being left in such relation to each other, as to indicate, not only their connection, but also the method by which the separation had been made. In this way the stem is not only broken once, but in some cases, several times. These facts, with others, incline the writer to the belief that the natural position of the crinoid was horizontal rather than vertical, living in the mud at the bottom of the sea.

The long slender arms, with their fringes of pinnulæ or tentacles, were also easily disjointed, especially at the point of connection with the calyx. Very few specimens retain them all entire. Frequently the arms are all gone, leaving nothing but the calyx. We have frequently found these long slender arms turned back upon the stem and disjointed, three or four of them sometimes, lying near together, some near the head, others a few inches back along the stem, as though the animal had left them behind in forcing its way through the mud. In removing the matrix from specimens, and especially in the large slabs, these detached arms are frequently met with. It will be seen from these facts, that the value of cabinet specimens must increase very rapidly in proportion to the perfection of the head, and the length of the stem.

It is an interesting fact that these Crawfordsville beds very clearly indicate a deterioration in the crinoids in ascending from the lower to the higher strata. In the outcrop near the level of the creek, are found remains of crinoids perfectly enormous compared with the same species higher up in the bluff. If the heads connected with these fragments of stems, bore the same relation to them that the heads above do to their stems, they must have been giants from eighteen inches to two feet in length. But no heads belonging to these stems have ever been found. As far as excavations have been made, the largest species and the largest specimens of species which extend to the top of the shale, are found in the lowest strata. Long ages must have elapsed during the formation of these rocks, and the period of life recorded in them.

Near the commencement of the Carboniferous period here represented, the crinoid seems to have reached the zenith of its glory in size and in numbers, and then began to wane, leaving in the same deposit the record of its glory and of its decline.

THE GEOLOGICAL SURVEY OF KANSAS.

A geological survey, carefully made, of any extended area, reveals the character of the rock formations for several hundred feet of thickness, and therefore makes known where *may* or *may not* be found the useful minerals—coal, salt, building-stone, iron, lead, etc.

Such a survey also makes known the *dip* or slope of the strata, and therefore gives indications of probable water supply in various localities.

Much geological knowledge of Kansas has been obtained, but it is in the

hands of private persons who have in their devotion to science made many explorations, but this knowledge is available by the public generally to a very limited extent. Within the last two years, geologists have found minerals in our western counties which further examination will doubtless show to be of considerable value, and which are even now being utilized.

Nearly all civilized countries have caused surveys to be made which, conducted simply as for the definite advancement of science, have yet revealed material resources which have largely added to the outlets for the useful employment of capital and labor.

Many of our sister States have caused geological surveys to be made, extending over a long series of years, which have made known mineral resources the use of which has greatly increased the wealth of the State.

In Michigan, there are now millions of dollars of taxable value in salt works, the existence of which is due entirely to the geological survey.

One county in Ohio (Tuscarawas) has a large industry in mining coal, the existence of which was made known by the geological survey. The State of Ohio as a whole has been immensely benefited by the survey, on which it has expended large sums.

The great State of New York has employed eminent geologists for a long time with experts in other departments of science, at a total cost of over half a million dollars, and the evidence of the most direct kind shows that the expenditure has resulted in the profitable investment of capital to a great amount; and unprofitable investments in prospecting for minerals, which were formerly common in that State, have ceased since the definite results of the survey have been made known.

In every State that has tried it, benefits have been received from this work in proportion to the time and expense that have been spent on it.

In our own State, the lack of definite knowledge as to the boundaries of our coal fields has led to the expenditure of capital in many useless undertakings. For example, in Morris County a shaft to the depth of three hundred feet was sunk; in Sedgwick County a depth of eleven hundred feet was reached, and in Marion a boring of seven hundred feet was made—all at great cost and without any returns.

Ignorance of the principles and facts that govern the supply of water in wells is in many places leading to similar wasteful experiments. A geological survey would stop this waste, and point out directions where labor would meet with reward and capital increase by investment.

The cost of a survey is so small, compared with the advantages to be reaped, that there should be no longer delay. A tax of one-twentieth of a mill would produce about as much revenue as it would require to put the survey in good working condition, though a larger sum would hasten the final accomplishment. This continued for a series of years would produce results in scientific and economic progress, of which all citizens would be justly proud.

THE LAST SUBMERSION AND EMERGENCE OF SOUTH-EASTERN KANSAS FROM THE CARBONIFEROUS SEAS, OR THOSE EFFECTING THE CARBONIFEROUS FORMATION IN KANSAS.

E. P. WEST, UNIVERSITY OF KANSAS.

[*Continued.*]

Since my paper, bearing upon this subject, was read before the Kansas Academy of Science, at its recent session in Lawrence, I have had an opportunity to extend the boundary of my observations to a limited extent; embracing a very small field of strata newer than the Permian formation.

These extended investigations tend to confirm the opinion I expressed in the paper referred to, that the wide-spread erosion in South-eastern Kansas may have occurred at a comparatively recent time. These newer strata were involved in it as well as the coal measures and Permian formation, and I have no doubt the cretaceous (if the newer strata referred to do not belong to it), tertiary, and early post-tertiary strata also. These and other facts which have been ascertained, pertinent to the subject, would indicate the later Post-Tertiary or Champlain epoch as the era of these occurrences.

Near Wellington, Kansas, and in a large area of country around it, extending westward to Harper and Attica, along the Southern Kansas Railway, ancient, modified drift is encountered. At Wellington, and many other places in the country adjacent, these beds are worked for the sand they contain. Fragments of the local rocks, which have been torn down from their beds, are profusely intermingled in them. The process of obtaining the sand, when mined, is by running it through a sieve to separate the drift gravel and fragments of local rocks from it. The pits show the gravel beds to be stratified, and evidently deposited by water, and being too extended for river work, they must be assigned to the same agency which wrought the distinction in other portions of southeastern Kansas, *i. e.*, to water aggregated in shallow seas. Mixed in with the sand, gravel, and fragments of local rocks, the bones of extinct post-tertiary animals are frequently found, namely, the mastodon, elephant, bison, and others whose species have not been determined.

In the Loess deposits, bordering the Missouri River, though not so frequently encountered, the bones of the same animals are found, together with the shells of Helix, Planorbis, Succinea, and other land and fresh-water shells identical with living species in the same locality. These remains are buried all through the Loess, from near the surface to a depth of from one hundred to two hundred feet.

The bones of a very large elephant were found in the alluvial deposits at

Ottawa, Kansas, and other similar bones in an equivalent deposit near Papinsville, Missouri. At this latter place the tooth of an extinct species of the horse was found in a bed of water-worn pebbles, under alluvial deposits, thirty-two feet below the surface.

Since my paper was read one of the students, Mr. Joseph Thoburn, has presented to the University some water-worn pebbles from Marion County, Kansas, which contain fossil shells identical with the shells of the undisturbed local rocks of that county and, a few days since, there was received, at the University, a fine specimen of petrified wood, from Russell County, sent by the Rev. J. D. Parker, U. S. A. This specimen is similar to the silicified wood referred to in my paper, and which is so generally distributed over southeastern Kansas. But whether this specimen was found upon the surface or in the alluvial deposits of that county is not stated.

Near Scipio, six miles north of Garnett, there is a small patch of rocks standing vertically to the plane of stratification, having evidently been tumbled down from a higher level. I am told they are sandstone, but I have only seen them from the car windows while passing on the railway. The other rocks, in the vicinity, are all limestone, and their stratification is undisturbed. Between Scipio and Garnett, and south and west of the latter place, sparsely scattered over the surface of the country there are found small masses of flint, from one to six or eight inches in diameter, very similar to that seen in the Flint Hills, and it is probable that a spur or local bed of the Permian strata, of no great thickness, was destroyed in this scope of country.

These facts in connection with those in my former paper would indicate pretty conclusively, that the denudation of southeastern Kansas and the deposition of the Loess along the Missouri River occurred at the same time; that the submergence involved nearly all, if not all, of Kansas as well as parts of Iowa, Nebraska, Missouri, Illinois, Arkansas, Louisiana, Indian Territory, and Texas, and, that a part of the Permian formation outlying in spurs or local beds may have been destroyed.

The submersion of the land was most probably as gradual as its emergence undoubtedly was, for the Loess deposits along the Missouri River could only have been made in still waters which were very gradually receding; and every successive inch of the river, from Omaha, Nebraska, to the present outlet of the Mississippi River at the Gulf of Mexico, at one time during the subsidence of the waters must have been the mouth of the stream.

The encroachment of the water began at the shore line of the Gulf of Mexico, wherever that may have been in the later Post-Tertiary time, and extended, more or less gradually, until the country within the limits before named, at least, was under water. During this time, the rivers emptying into the seas would deposit sediment at their mouths, and the mouth of the stream would recede, upward, as the waters of the seas advanced. But it was during the retiring of the water that the Loess deposit was given its final and distinctive character as such. The recession of the water was from up the streams downward, and the

mouth of the rivers would advance and leave their deposits of sediment, as the water of the seas retired.

But none of the rivers which emptied into those seas have a well-defined Loess deposit except the Missouri. The Kansas, the Arkansas, and their tributaries seem to have had their debouch into interior lakes during the recession of the water and their sedimentary deposits, which were very limited in amount, were made in them. The Missouri was the only river, perhaps, which had an uninterrupted gradual fall during the elevation of these lands for the last time.

Most of the Post-Tertiary animals, which before had drawn abundant sustenance from the country, were destroyed by unfavorable conditions and became extinct during this last invasion of their province.

Another important question remains to be answered, *i. e.*, whether man witnessed these occurrences? We have reason to believe that he did, and survived the unfavorable surroundings which destroyed most of his humbler co-habitants. His remains have been found, both in Europe and in this country, associated with older formations. His bones and implements have been found in the alluvial deposits of this era under conditions which leave but little doubt that they were buried in, by natural agencies, during their pendency. His monuments stand out, conspicuously, in unbroken lines, for hundreds of miles from the summits of the graceful Loess hills which had their birth in this epoch. He has sculptured the greatest of the extinct mammals, and could only have drawn the conception from the living animal. The conditions were not very dissimilar from those of to day; and we may feel assured that he played a leading part at this stage of the world's progress, as he has since done in a more conspicuous manner.

Before closing this paper it is but just that I acknowledge, on behalf of the University of Kansas, the courtesy of the officers of the Southern Kansas Railway extended to it, and thank them for the interest they have always manifested in the advancement of science and the development of the material resources of Kansas, especially those great interests along the line of their road. Personally, I must acknowledge the invariable kindness I everywhere received from all the officers and employees of the road during my work along its line; and the pick and shovel, associated with these courtesies, will ever be among my pleasant remembrances.

KANSAS SCIENTIFIC SURVEY.

PROF. JOHN D. PARKER, U. S. A.

The Kansas Academy of Science, at the late annual meeting at Lawrence, took steps to inaugurate a thorough scientific survey of the State of Kansas. In the early history of the State two preliminary reports were made by Professors Mudge and Swallow, and the members of the Academy have made valuable

contributions to our knowledge of the science of the State in several departments. Prof. O. St. John, the accomplished paleontologist, has run a stratigraphical line along the Kansas river from Wyandotte to Manhattan, has carefully determined the formations, and has drawn a chart representing the strata along this base line. He has also, during the past year, located some valuable coal fields in Southern Kansas beyond what was supposed to be the boundary of the coal formations. Prof. Frank H. Snow of the State University has made important contributions to our knowledge of the birds and insects of the State, and of the fish in the Kansas River. Prof. E. A. Popenoe of the Agricultural College, has made valuable additions to our knowledge of the insects. Professors Carruth and Snow, with the assistance of others, have worked faithfully on the catalogue of the plants of the State. Profs. Snow and Lovewell, Major Hawn and others have taken meteorological observations for years, and have done much to determine the climate of Kansas. Mr. Robert Hay has performed some excellent geological work in Norton county, under the auspices of the Academy, and has published a geological map of the county. Professor F. W. Cragin of Washburn College has published partial lists of Kansas mosses, lichens, algæ and fungi, and has made a good beginning in collecting and identifying the lower plants of the State. The chemists have also been at work, and Professors Failyer, Patrick, Bailey, and others have made some valuable analyses. All of this labor of the Academy, covering about two decades of years, has been accomplished by volunteer workers, without costing the State of Kansas a single dollar.

The time has now fully arrived for the Kansas Legislature to take up the scientific survey of the State, to utilize the results already attained, and to carry on the work so well begun to its completion. Kansas is unusually rich in mineral resources which need to be developed by a thorough and complete geological survey. Very little is known at present of the immense coal fields of the State. The lead interests are still in their infancy. Probably there are zinc deposits undetermined. The State has unlimited beds of limestone and freestone, constituting the finest building material in the West, much of which is undeveloped. The Burlington Gravel Beds furnish some of the best gravel for our street pavements, and would, if thoroughly explored, furnish an abundance of the best ballasting for railroads. A physical survey would determine the water power of the State, enabling capitalists to plant factories wherever they can be established. Little is known of the saline deposits of the State. The vast gypsum beds of Kansas need development. A thorough and complete survey would develop these immense resources, form a basis for material industries of every description and add largely to the wealth of the State.

Geological surveys have been prosecuted in the leading States of the Union with the most valuable results. In Michigan there are now millions of dollars of taxable property in salt works, the existence of which is due entirely to the geological survey. The survey developed two rich salt deposits, and the annual export of salt has now reached about a million dollars. The Ohio geological survey developed a fine industry in mining coal in Tuscarawas county. New

York has spent over half a million dollars on her scientific survey, and her rocks have become classic ground. The New York scientific nomenclature is known in all countries, and is the nomenclature of our best geological text books. Her survey has resulted in the profitable investment of a large amount of capital, and since the definite results of the survey have been made known, the unprofitable investment in prospecting for minerals, formerly so common, has ceased. Several other States have prosecuted geological surveys which have fostered many industries and added much to their material wealth.

But the scientific survey of any country has, we believe, a higher and a broader plane than even the development of its mineral resources. A free and an intelligent people, like those of Kansas, stand related to nature, at many points where science touches the inner life. Nature in her material aspects, contributes to our physical wants, and supplies from her abundant resources the materials with which our homes are constructed, furnished, and beautified. But in a deeper sense nature speaks a language which fills the thoughtful mind with higher and better truths. When nature unfolds her deeper meaning to the percipient mind science begins to fertilize every department of life. The people of Kansas need ample collections in all departments of nature to illustrate scientific studies. The State has already suffered irreparable loss in the transportation from her Western borders of the finest and rarest specimens, to enrich the cabinets of Eastern colleges and universities. Prof. Marsh of Yale College has paid $1,000 a year to cover the transportation of vertebrate fossils, collected in Western Kansas. Such materials are the richest endowments of educational institutions, and are indispensable in educational processes when conducted on the best plan. Kansas can ill afford to let Eastern institutions rob her colleges, on account of her lethargy, of rare material of learning which, once gone, can never be replaced.

During our civil strife, Kansas won golden opinions over the civilized world for the advanced position she took and held in the maintenance of the ideas of freedom. She has a double land grant for the establishment and maintenance of public schools, and her State University has already exhibited a wonderfully vigorous growth. Her Agricultural College, in spite of many discouragements in past years, is beginning to yield excellent results. Intelligent people all over the State are very anxious to have the scientific survey begin at the earliest practical moment, for Kansas cannot afford to lag behind her sister States in this fundamental work which lies at the base of the highest physical development and the best intellectual culture.

The Legislature of Kansas can not do any act which will contribute more to the welfare of all the people of the State and be more acceptable to all intelligent citizens, than to inaugurate the geological survey of the State during the coming session.—*Kansas City Journal.*

THE AGE OF THE WORLD.

REV. L. J. TEMPLIN.

Scarce a generation has passed away since it was the almost universal belief among the common people that the earth, in both its material and form, was only about 6,000 years old. When geology began to teach that the age of the world was to be reckoned by not only thousands and tens of thousands, but by millions of years, it was arraigned as being in opposition to the word of God, being infidel if not atheistic in its tendencies. But now, few if any persons, who have any just claims to be considered intelligent, question the great antiquity of the earth. But only those who have given special attention to the subject are aware of the vast amount of evidence in favor of this view that is presented by the present condition of the rocks composing the solid crust of the earth.

To give even an abstract of all the proofs that exist in favor of this doctrine would require a large volume; much less can it be compressed within the narrow limits of a magazine article. A cursory view of a few representative facts and general principles, is all that can be attempted in the present discussion.

There was doubtless a period in the earth's history when its whole mass was in a state of igneous fusion. When it had become sufficiently cooled to permit the existence of water on its surface, currents would be formed, and erosion would begin. The eroded material would be deposited in still water and form sedimentary rocks. These would be laid down in horizontal, or nearly horizontal, strata. The cooling of the earth would cause contraction, and this would produce subsidence in places and upheavals in others. By these means the strata, already laid down, would be broken, contorted, and tilted at various angles, leaving the edges exposed. As erosion would go on, new strata would be deposited on the upturned edges of the older strata, but unconformable with them. These coördinate processes would go on as long as the vertical oscillations in the crust of the earth should occur. And they have been in operation from those early times, when all the water on the earth was probably kept at a boiling temperature, till the present, and we find them still in operation, and still producing the same results. In studying the sedimentary rocks, it should be always kept before the mind, that they have been formed by the double process spoken of above; and that these have exactly balanced each other; the denudation being exactly commensurate with the deposition. The amount of this sedimentary matter, in the aggregate, is enormous.

The various formations vary greatly, being thicker in places, thinner in others, and entirely wanting in still others; but taken altogether, they constitute a thickness of about 72,000 feet, or thirteen and a half miles. In considering these rocks in relation to time, the mind should divest itself of all idea of reducing it to any statement in years. But there are numerous facts connected with

their formation that indicate an enormous lapse of time. The enormous depth and vast extent of some of these formations, with certain attendant facts and conditions, impress the mind almost with the force of a demonstration, that the lapse of time during their formation must have been inconceivably great. Let us begin with the Laurentian, the oldest fossil-bearing rock known to exist. These are found to exist over a wide extent of country in both America and Europe. They attain their greatest known development in Canada, where they exist to the thickness of 40,000 feet. Supposing that they were formed by the gradual detrition of older rocks, and the deposition of the debris at the bottom of the ocean, the time required for the accumulation of such vast quantities of rock material must have been very great. This fact seems further evident from the presence in these rocks of certain substances that were accumulated in them during their formation. Interstratified with the rocks, and sometimes existing in pure beds, is found large quantities of graphite. This is doubtless the result of the perfect carbonization of vegetable matter.

The growth of this vegetation would require long lapse of time, after which it would probably pass slowly through the various grades of lignite, brown coal, and anthracite, before reaching the stage of graphite. Another fact that seems to demand the same interpretation in its relation to time, is the vast deposits of iron ore during the Laurentian period. It is in the rocks of this period that we find the rich iron beds of Missouri, New Jersey, Lake Superior, and Sweden. This ore is supposed to have accumulated by the leaching of the oxides and carbonates of iron from the rocks, and its precipitation under the influence of decaying vegetation.

Now if all the vast beds named above have been deposited by this process, it must have consumed almost inconceivable time. The great Iron Mountain, of Missouri, itself is estimated to contain not less than 600,000,000 tons of iron above the level of the surrounding country. Extensive beds of limestone are also found here; and as these are supposed to be composed of the shells of molluscs and protozoans; the time for them to live and die in quantities sufficient to form such extensive beds of their calcareous remains, could scarcely be reckoned in years. Next above these Eozoic rocks are the Silurian, aggregating a thickness of over 25,000 feet, and crowded with fossils, both animal and vegetable. More than 10,000 different species of fossil animals are already known to belong to this system. These are not, as we would naturally expect from the age of the rocks, of simple and primitive forms; but they are of widely differentiated and highly specialized forms. Coming in as they do, suddenly, in such great variety, and on such a high plane of organic life, how to account for their origin on the hypothesis of evolution has been a very difficult problem. In order to surmount the difficulty, believers in this doctrine generally take refuge in the assumption that between the close of the Eozoic age, and the beginning of the Silurian age, as represented in the rock of the two systems, there must have been an enormous lapse of time, exceeding in extent all the time required for the formation of the rocks composing both these systems.

It was during this long interval that all these organic forms were evolved by natural selection. When asked why such must have been the case it is answered that we must admit this explanation or we have no explanation; and because it cannot be disproved, therefore it must be true. And this is called science. There is abundant proof of the enormous lapse of time without resorting to this manner of assuming that our ignorance is knowledge. Such a lapse of time may have passed in this interval, but that such was the case is without proof except as the evolution hypothesis is assumed as proof; but this itself is sadly in need of proof. We pass over the next—Devonian—age with the single remark that the rocks of this system, containing the fossil forms of numerous species of organic forms, especially fishes, give proof that long ages must have elapsed during their deposition.

We next come to the carboniferous age—age of acrogens or coal age. Here we find the most indisputable evidence of enormous stretches of time. The foot-prints of time are so indelibly impressed on the rocks of this age, that in some places some approximation to a calculation may be made. The thickness of the rocks of this system vary from 9,000 feet to 15,000 feet. The coal-measures proper vary between 4,500 and 13,000 feet. We here have the most irrefragible proofs of the frequent oscillation of the earth's crust. The seams of coal, which compose but a small portion of the thickness of these rocks, are interstratified with the various strata of sandstones, shale, and limestone composing this formation.

As coal is the product of vegetation, which must have grown at the surface, it is evident that to form the seams of coal found at various depths would require that each of these various horizons should have been at the surface at the time when the material forming the coal was accumulated. Now, we find in different coal-fields considerable numbers of these seams separated by intervening strata of rock. Thus in Nova Scotia there are 81; in Wales 100; in Belgium 100; in Westphalia 117. These aggregate, in some cases, as much as 150 feet of coal that would be passed through in sinking a shaft from the surface to the lowest coal-seam. It is evident that where these different seams are found, the land has been elevated and depressed at least once for each of the seams found.

There would be a long period when the land surface was above the water; immense forests of vegetation would flourish until a huge layer of it was accumulated, when by some convulsion of the crust of the earth, or by a gentle—perhaps to human eyes it would have been imperceptible—subsidence, it would be depressed below the waves and receive, either from fluviatile or marine sediment, a layer of earthy material, covering the layer of organic matter to a depth of many feet. A reversal of the process by which the land was depressed, again elevates the surface above the waters, and again a layer of vegetation would be produced, to be in turn buried as the former was. And thus these alternate elevations and depressions continued till, as we have seen in some cases, an hundred or more beds of vegetable matter have successively grown

and been buried. The pressure and heat to which this organic matter was subjected after such burial, eliminated the greater portion of the volatile gases and converted it into coal. The time necessary for the accumulation of all the organic matter contained in all these strata, and in the subsidence and elevation, and for the deposition of the sedimentary materials composing the rocky strata interposed between these coal-seams, can not be estimated—even approximately. But we are sure it must have far exceeded all conceptions of duration that we can form from our knowledge of human history. We have no data on which to base any estimate of the rate of the accumulation of sedimentary matter, except the present rate of sedimentary deposition at the mouths of rivers. The present average amount of sediment carried down by the Mississippi amounts to enough to cover one mile square to a depth of 268 feet annually; or about one cubic mile in twenty years. At this rate it is estimated that it would have required about 1,000,000 years to have carried down and deposited the amount of materials that originally composed the rocks of the coal-measures in the coal-fields noticed above.

The time occupied in the growth of the vegetation that formed the various beds of coal may be more nearly approximated. If we assume the amount of vegetation growing on one acre at 2,000 pounds, this would give in 100 years 100 tons. This compressed into coal and spread over an acre of ground would give a thickness of one-eighth of an inch of coal in a century; or 10,000 years would be consumed in producing one foot of coal. This would require, to produce 150 feet, as found in some regions, no less than 1,500,000 years. But probably the growth of coal-plants, with the very high temperature and heavy atmosphere, laden as it was with carbonic acid that prevailed during the coal age, would produce a much larger growth of vegetation than we have estimated, and the time would be accordingly diminished. But making due allowance for this, there is no question but the time required for the growth of all this vegetable matter, the frequent subsidences and elevations, and the accumulation of the sedimentary matter composing the rocks of this formation must have required many hundreds of thousands if not millions of years.

Another remarkable illustration of alternate elevation and depression, or at least of alternate land and water surface is found in the Amethyst Mountain, in Yellowstone Park. This mountain is made up of alternate layers of sand-stone and conglomerates, and the remains of gigantic forest trees. The stumps and trunks of these trees are found imbedded in the rock material of the mountain at various altitudes; the stumps five to six feet in diameter, and the trunks sixty feet long. It would seem that a forest of these gigantic trees would flourish for a time—perhaps for centuries—and then be overwhelmed with a flood, bringing down sand, gravel, and broken stones, completely covering the site of the forest. This would become the soil upon which another forest would spring up and grow, only to be buried up as its predecessor was. And this process of alternate growth and burial has gone on till from one to two score of these gigantic forests have flourished and passed away. Since the last one passed

away the mountain has been elevated 3,000 feet above the river. The time required for all these changes must far exceed all our conceptions of duration.

It is an undoubted fact that the topography of the present surface of the earth has been largely affected by erosion. This process is constantly going on, degrading the eminences, changing the declivities, and gradually wearing away the whole surface of the land. The sum of this erosion, since the last great geological changes, is enormous. The amount of erosion over many portions of England is estimated at 10,000 to 11,000 feet.

In the Appalachian region it is proved that the erosion has amounted in some cases to not less than 20,000 feet in depth. In portions of the Rocky Mountain regions this erosion has been still greater. Professor Powell informs us that in the Uintah region the amount of erosion has exceeded five miles in depth in some places, with an average depth of three and a half miles over 2,000 square miles of country. The time necessary for the removal of so large an amount of material of course would depend on the agencies employed and the energy with which they operated. It would undoubtedly be vast.

Water, aided by frost, is probably the principal agent operating in producing all the erosion that has taken place on the earth. The power of water to "wear away a stone" is witnessed in the wonderful channels they have cut for themselves during the present geological age. The Niagara River has cut a channel about 200 feet deep a distance of seven miles. Mr. Lyell estimates 36,000 years as the time necessary for the accomplishment of the task; but as we know neither the present nor the past rate of progress the river has made, such estimates are perfectly unreliable.

A very noted example of river erosion is exhibited by the Grand Cañon of the Colorado River, which is 300 miles long and from 2,000 to 6,000 feet deep. But we have no data from which to estimate the time required for the river to cut its way through this distance of rock. We do not know the present rate of recession, nor do we know but the river simply followed and enlarged a crevasse that had been formed by some convulsion of nature. As all such data are unreliable, all conclusions drawn from them must be fallacious.

The general erosion of the whole surface of the earth may be estimated by measuring the amount of sediment that is now carried down by the rivers of the globe. As we have previously stated, the amount of materials composing the sedimentary rocks is the amount that has been eroded. This, it is estimated, would be equivalent to 2,000 feet in depth over the whole surface of the earth; and if taken from the present land surface, it would equal an average of not less than 6,000 feet over the whole land surface. The average erosion of the general surface of the earth as estimated from river sediment cannot be less than one foot in 5,000 years. At this rate it would require, to remove an average thickness of 6,000 feet no less than 30,000,000 of years. And this is the estimate some would place on the age of the earth, since the first sedimentary rocks were laid down.

But two facts present themselves for consideration here, that go far to vitiate

all such estimates. One is, the fact that in the earlier ages of the world, the higher temperature that prevailed, and the large per cent of alkaline and acid substances held in solution by the water, would greatly increase its erosive power, thus requiring a far shorter time to produce a definite amount of sediment than is required at the present time. This would require a large reduction of the above estimate. But on the other hand we have the fact that the erosion that is now taking place is principally operating on sedimentary rocks; and doubtless this has been true during a great portion of geologic time. The same material has been laid down and removed again and again, so that an estimate of the time that it would take to deposit the materials of the sedimentary rocks as we know them, gives but a very slight clew to the time since the beginning of their deposition.

We conclude, therefore, that all efforts to deduce from the above data any definite estimate of the age of the earth in years, are futile; and all conclusions drawn from such calculations are fallacious and misleading. In the beginning of this article we spoke of the probable fluid condition of the earth: but if this theory is correct, it is evident that that is not the beginning of the earth's history. The same reasoning that would demand such a condition, would lead us on to a period when this same matter was in a gaseous state; when as incandescent gaseous matter, it was expanded in space. But supposing this to have been the true history of this world, it is evident that no data exist on which to found any estimate of time as applied to this stage of its existence. It is only when it has reached a liquid condition that any basis is furnished for a calculation of time as applied to its history.

Different scholars have attempted a calculation of the age of the earth from the rate of cooling of heated bodies exposed to a cold atmosphere. But the various elements entering into the mathematical analysis of this problem, are so numerous and uncertain, that there is no agreement in the conclusions arrived at. These conclusions vary from 160,000,000 to 600,000,000 of years as the probable time required to bring the earth from a fluid state to its present condition.

From all the foregoing considerations we are led to the conviction that though the earth has existed for an inconceivable length of time, yet from the data at command it is impossible to reduce it, even approximately, to years; that these unmeasured and unmeasurable years are known only to Him who is from everlasting to everlasting, yesterday, to-day, and forever.

CAÑON CITY, COL., January, 1885.

BIOLOGY.

ON THE WASHBURN BIOLOGICAL SURVEY OF KANSAS.

F. W. CRAGIN, SC. B.

It is proposed to conduct, under the auspices of Washburn College, an informal biological survey of Kansas. The work has already been in progress for some months, and will probably require five, and perhaps ten, years for the accomplishment of its objects.

While the more popular portions of our fauna and flora, and particularly our birds, insects, and flowering-plants, have been studied by Profs. Snow, Popenoe and Carruth, Col. Goss, and others, no attempt has hitherto been made at a systematic survey of the entire field of Kansas botany and zoölogy. The work now proposed, while placing our State in a position where, as regards our knowledge of its natural history (geology excepted), it will compare well with its older sisters in the East, will present to science the facies of a typical prairie fauna and flora, will serve to define more clearly the relations of the Eastern, Central, Sonoran and Austroriparian faunal regions, and cannot fail to throw other important light upon the subject of bio-geography and variation.

We have said "geology excepted" because, while there are few States of whose geology, whether considered in its scientific or in its economic aspect, so little is known as of that of Kansas, it is neither part nor possibility of the present undertaking to include a State geological survey. Such a survey is imperatively needed, but is of too great magnitude for private enterprise, and its execution must be left to the State.

The object of the proposed survey is simply to investigate the fauna and flora of a State which, together with Indian Territory, holds the key to a more definite knowledge of the inter-relationship of four great faunal regions. It is believed that this object will commend itself to all intelligent and public-spirited citizens of the State; and the coöperation of such is invited in the collection and donation of specimens of mammals, reptiles, fishes, shells, insects, crustaceans, flowering plants, ferns, mosses, lichens, *Fungi*, *Algæ*, or, in short, of whatever lines of material can locally be collected to best advantage.

The progress of the survey will be recorded in the form of partial reports, or contributions and notes, which will come from specialists to whom the material brought together by the survey will be submitted.

Some of the departments are still unprovided for; but the names of the following eminent specialists, whose services have been secured, are a sufficient guarantee for the value of the proposed work: For the fishes, Prof. Chas. H.

Gilbert, of Bloomington, Ind.; land-shells, Mr. Arthur F. Gray, of Danversport, Mass.; fresh-water shells, Prof. R. Ellsworth Call, of Des Moines, Ia.; mosses, Mr. Eugene Rau, of Bethlehem, Pa.; lichens, Mr. H. Wiley, of New Bedford, Mass.; *Algæ*, Mr. Francis Wolle, of Bethlehem, Pa.; *Agaricini*, Prof. C. H. Peck, State Botanist of New York; lower *Fungi*, J. B. Ellis, of Newfield, N. J.

A considerable number of volunteer resident collectors and correspondents have already been secured in various parts of the State, and it is hoped that many others may be added. The following points, as yet unprovided for by resident observers, are particularly important stations; and we shall be glad to correspond with any one who can represent these localities for the survey, or direct its attention to such as they think might be able to do so: (1) the Kansas shore of the Missouri River; (2) the Marias des Cygnes Valley, near the eastern State line; valley of (3) Spring and (4) Arkansas River, near the southern State line; (5) Medicine Lodge; (6) extreme southwestern Kansas; (7) Republican Valley, near the west line of the State; (8) Norton County; (9) Blue River Valley, near the northern State Line.

Correspondence is invited from all interested in the subject of natural history in Kansas. Communications and specimens relating to the survey should be addressed to F. W. Cragin, Washburn College, Topeka, Kansas.

Circulars are in course of preparation, giving directions as to the manner of collection, preservation, and transmitting of specimens best calculated to subserve the objects of the survey, and these circulars will be forwarded to any address on application.

Two reports on the progress of the survey—published in the *Bulletin of the Washburn College Laboratory of Natural History*—have already been completed, and the material for the third is largely in hand.

The following sketch will give a fair idea of the general method of the work and of results thus far attained and those still sought:

To the list of Kansas mammals as given by Prof. M. V. B. Knox, some years ago, the survey has been able to add a number of species, among the most interesting of which, as considerably extending the known geographical distribution of the species, are the Mexican Badger, two specimens of which have been found in central Kansas, and the Free-Tailed Bat, found in the northeastern part of the State. Both are southern species and their occurrence in Kansas is a matter of some surprise. It has also added to the State Fauna the Georgian Bat, and is able to record through the favor of Prof. Snow, the Little Shrew, *Blarina parvula*, from western Kansas. It would call attention also to the long lost Black-footed Ferret, or Prairie Dog-Hunter, of western Kansas, whose rediscovery was recorded a few years since by Dr. Coues, and would urge our collectors and hunters to keep vigilant watch for it with a view to ascertaining its distribution and abundance in the State. Does the distribution of this ferret coincide with that of the Prairie-Dog? The survey is also gathering statistics with a view to determining the exact distribution of the Prairie-Dog in Kansas, and its relations to civilization and agriculture. Is the Prairie-Dog favorably or adversely

affected by the advance of civilization upon him? Have the "deserted towns" of this animal become such owing to a desire to shun observation and molestation by man, or were the migrations which they record induced by desire for better forage grounds, or by other causes? Items of information tending to shed light upon the distribution, increase, or extermination, habits, and economic relations of this and other species of the animals of Kansas are greatly desired. For some of our species the historical material must be gathered at once, or it will never be fully known. With birds, as already intimated, the survey is not concerned.

In Reptiles, perhaps the most interesting discovery is that of a second species of Green Snake, the slender Green Snake, *Cyclophis æstivus*, an austroriparian species, collected by Col. N. S. Goss, at Neosho Falls. Kansas is doubtless the northern limit of this bright-hued, active, southern serpent.

Of Fishes the survey has made considerable collections, mainly of smaller forms. Three species new to science have already been described in its reports, and the pretty little Zebra Fish of the Rio Grande River, known until recently by Girard's imperfect description only, has been re-discovered and fully described from material sent from Ellis, Kansas, by Dr. L. Watson. The Zebra-Fish has since proved to be one of the commonest fishes of western Kansas, scores having been taken from a little stream near Garden City by the writer in two days' collecting last August. The Lamprey Eel of Kansas, parasitic on the Buffalo-Fish, etc., proves to be usually the *Chestnut* Lamprey, and the material collected tends to confirm the suspicion expressed by Jordan and Gilbert in their "Synopsis of Fishes of North America" that this and the Silvery Lamprey may be only varieties of one and the same species.

In Insects, the survey has paid attention to only the order of Locusts, including the grass-hoppers, locusts, crickets, and "devil's horses." Collections have been secured in eastern, central and western Kansas and a report on these will appear in *Washburn Bulletin No. 3*.

A few Spiders, Centipedes, and Scorpions have also been collected and in part determined. Of the first, the great "Bird Spider of Texas," sent us from Chautauqua County, by Mr. Charles Hosford, is the most noticeable; and of the second, the long-legged Forceps—centipede, or "Carpet Sweeper" (*Cermatia forceps*), from several localities, is quite a unique.

The collection of fresh-water Crustacea is considerable, but is yet to be studied.

In Mollusks, the survey has collected about fifty species of river- and pond-bivalves, some three-fourths of which have been named, and about thirty species of land and fresh-water snails, mostly determined.

In Worms, little has been done; but a most interesting discovery is that of a still unpublished species of fresh-water Polyzoan, common in our creeks, and the first, apparently, recorded from the plains. It is a branching form, a *Fredericella*, and its graceful resupinate sprays grow upon submerged stones and mussel-shells. The short, stout Hair-Worm, *Gordius robustus*, has been found in Waubaunsee County, and one or two other species have been collected but not determined.

No Fresh-water Sponge or Hydroid has yet been found in our Kansas waters. With our Rotifers and Rizopods nothing has yet been done. Some work will be attempted on them another season.

A brilliant red Infusoria, an *Englena* whose specific name now escapes me, I found in August, on a wet mud flat by a shallow pool in Waubaunsee County, in such multitudes as to make a considerable area to appear as though coated with blood. Until within a few years this genus was regarded as a plant. It is not, however, the expectation to undertake much with the Infusoria, as these are so largely cosmopolitan in their distribution.

In Botany the survey has concerned itself with the Cryptogams only. A number of botanists are diligently at work with the flowering-plants, and it is understood that no less than four of these propose to give us independent accounts of the phænogamic flora of Kansas. Further work on the Phænogams is therefore uncalled for.

In the Ferns, collections have been made and two papers published which have added a number of names to the record of Kansas species. Amongst these I may mention the luxuriant Marsh-Fern (*A. Thelypteris*), contributed from Pottawatomie County by Mr. A. McMillan, and the Hardy Lip-Fern (*Ch. lanuginosa*) and the Wright Cliff Brake (*P. Wrightiana*), contributed from Ottawa County by Mr. C. C. Olney. The species and varieties of ferns known to occur in Kansas now number twenty-four.

In Mosses, Fresh-water Algæ, and Lichens, lists have been begun, though the number of species recorded is small, compared with what are yet to be recorded. Among the Algæ, after the large green scums of matted threads (*Spirogyra, etc.*) common in pools and watering-troughs, the most conspicuous is perhaps what may be called the "Swimming-bell Alga" (*Glœotrichia natans,*) which was found in Lake Inman in August, and which seems not to have been previously detected in western North America. The gelatinous frond of this plant has at first the form of an inverted saucer or shallow cup, with margin rolled in beneath. After this has attained a length of two or three inches it sends out long finger-like lobes and becomes very irregular in form, the entire plant sometimes attaining a length of two or three feet. The resemblance in general habit of the young "blubber-cups" to certain of the curious jelly-fish known to the mariner as "sea-blubbers" at once suggests itself, though we must not look for tentacles nor scrutinize in any way too closely; and, as they float in the open spaces left by the confused colony of brown, long-fingered, older fronds, it is easy to fancy them such, floating among the sea-weeds of some quiet bay. Thus do the insignificant lakelets of the plains in the heart of a great continent simulate scenes of the ocean.

In Fungi, the survey has collected over two hundred species, mainly non-parasitic, of which nearly all have been reported in the *Washburn Bulletins*. In this department of the work, Prof. W. A. Kellerman of the State Agricultural College coöperates and has reported about one hundred eighty species of parasitic fungi and thirty-two miscellaneous. Making allowance for the few species

common to these lists, the number of fungi thus far determined in Kansas is about four hundred, a considerable number among them new to science. The number of perishable fungi collected but not determined would doubtless double this number; and the number of fungi that occur in the State is probably not short of two thousand.

Such are some of the results that up to this time have been gained toward the development of the knowledge of the botany and zoölogy of Kansas. Much remains to be done and it is hoped that the aid of every observer in Kansas will be heartily extended to the survey so that the results, based upon an abundance of material, may be full and conclusive; a credit alike to the collaborators and to the State.

ASTRONOMY.

VELOCITY.—III.

EDGAR L. LARKIN.

MOTION IN THE SIDEREAL STRUCTURE.—In (I), this REVIEW, Volume VII, page 764, we presented the fact that a body falling on a straight line from an infinite distance to the Sun, not meeting resisting medium, will strike with a velocity of 382.956 miles per second. This is the maximum velocity that can be imparted to a falling mass by the attraction of the Sun and in these notes is termed G. It is the most valuable constant in nature yet detected by mathematicians. By its use, rates of motion generated by solar gravity in the remotest solitudes of space can be computed with little work.

Since G=velocity of impact or the Sun from infinite distance, terminal motion from any finite distance can be determined with ease by means of G in simple formulas. On page 766 we made calculation of velocities of collision from several finite distances ranging between 1 and 20,000,000 solar radii. Because it is difficult for cosmic masses to strike the Sun, few collide while many dash around it on orbits, we gave (Volume VIII, page 188,) velocities of bodies that escape collision and retreat to interstellar voids. These discussions relate to motion displayed near the Sun; but we desire to make research on velocities observed in that small part of the sidereal edifice visible in telescope.

Assume a stone at rest at an infinite distance from the Sun, and let it fall on a straight line, then since we know G, the velocity of the falling body while passing a point at any finite distance can be determined by making G a factor.

Thus:—if a mass from infinite distance approach the Sun, its velocity at any finite distance expressed in solar radii is equal to G multiplied by the square root of the quotient obtained by dividing the distance by its square. If we call

the radius of the Sun r, the Earth's distance is 214r, whose square =45972. Then—214÷45972=.046638 whose square root=.06829×382.956=26.15 miles per second velocity acquired by the mass at the orbit of the Earth on arrival from a distance that is infinite. Solar gravity acts on all cosmical bodies, which would move toward the Sun unless restrained by an opponent able to counteract attraction. Such energy is centrifugal tendency, a tendency generated by velocity. It is known how great orbital motion is required to evolve centrifugal tendency equal to gravity at any distance; hence the ratio of such velocity to velocity derived from fall from infinite distance can be ascertained.

Having found this ratio, it can be extended to any depth of space, and motion computed. If a body revolve around the Sun with velocity sufficient to cause centrifugal tendency to equal centripetal, such velocity is equal to G multiplied by the square root of the quotient obtained by dividing the distance at which it revolves by *twice* its square. We have for the motion of the Earth—twice the square of 214=91945, when 214÷91945=.002332 whose square root =.0483× 282.956=18.49 miles per second orbital velocity necessary to keep it from fall-toward the Sun. But, 26.15÷18.49=1.414213, hence the sought for ratio of orbital velocity at a distance of revolution where such motion evolves centrifugal tendency equal to gravity, is to velocity of fall ot the same distance from the Sun of a falling body that begun its fall at an infinite distance as 1 is to 1.414213.

Now, 1.414213 is the square root of 2, hence this ratio of velocities must be correct, for if we take the square roots of quotients derived from dividing a number by the square and twice the square of another, this relation of roots must inevitably obtain. This ratio may be said to be a characteristic of gravity and motion and exists wherever matter does, or is at liberty to move in obedience to gravitation. Let us again note from I and II the properties of this square root of 2. If we should dig a well from the surface to the centre of the Sun and drop in a stone, it would reach the centre with a velocity of 270.79 miles per second. But this is equal to 382.956÷2.414213, whence a mass falling from the surface to the centre of the Sun will acqure seventy per cent of the velocity attained on reaching the solar surface had it been falling since the "beginning." Again—a body taken into space distant 1 radius of the Sun and let fall, will make impact with this same velocity—270.79 miles per second. Or,—a stone a few miles above the Sun's surface (in absence of retarding matter) having orbital velocity=270.79 miles per second, will not fall but make revolution like a satellite; or should the Sun's equator revolve with that rate, masses lying upon the surface would be without weight. If a comet move with velocity equal to the square root of 2,—velocity of a planet at same distance where centrifugal tendency and gravity balance, being equal to 1, then will the comet pass round the Sun and retire never to return. Should its motion be less, say 1.38 or similar velocity, then it will fall on some form of ellipse and make future circuits. In short—velocity on closed is to velocity on open conics; or orbital velocity at finite is to velocity of fall from infinite distance as 1 is to 1.414213. We extend this principle to the sidereal heavens seeking to learn what rate of motion solar gravity

is able to cause among other suns so distant that their light requires centuries to traverse the mighty wastes between. We present this table of distances and velocities. Column I gives distances from the Sun's centre in trillions of miles, II, orbital velocities in miles per second of bodies in revolution around the Sun where centrifugal tendency equals gravity; III, same in miles per hour; IV, falling velocities acquired by bodies that fall from infinite distance, on arrival at orbits of revolving bodies; V same in miles per hour:

I.	II.	III.	IV.	V.
Distance.	Orbital Velocities, Miles per second.	Same, Miles per hour.	Falling Velocities, Miles per second.	Same, Miles per hour.
1.	.1788	644.	.253	910.
5.	.0797	287.	.1125	406.
10.	.0563	203.	.0797	287.
16.	.04474	161.	.06327	228.
20.	.039	140.	.0563	203.
32.	.03163	114.	.04474	161.
40.	.02757	99.	.039	140.
64.	.0224	80.	.03163	114.
80.	.019	68.	.02757	99.
128.	.0158	57.	.0224	80.
256.	.01117	40.	.0158	57.
512.	.0079	28.	.01117	40.
1,024.	.005586	20.	.0079	28.
2,048.	.0039	14.	.005586	20.
4,096.	.00276	10.	.0039	14.
8,192.	.00195	7.	.00276	10.
16,384.	.00138	5.	.00195	7.

This table was calculated by employing G once to find falling velocity at five trillion miles as indicated in formula. This was all that was required for having falling velocity at a given distance, orbital velocity was obtained directly by dividing by 1.414213. Both velocities being known, the whole table may be made in a short time by simple division, or by proportion or by interpolating.

Thus: orbital at five, is the same as falling velocity at ten trillion miles, and so on. This must be true since velocity at a distance divided by the square root of 2 equals velocity at twice the distance, a result that obtains because gravity varies inversely as the *square* of distance. But one cannot fail being impressed with the majesty of the Sun, or his mighty power of attraction.

We see that a body distant twenty trillion miles must move with a velocity of .039 miles per second or 140 miles per hour in direction at right angles to radius vector, or it is falling toward the Sun. But twenty trillion miles is the distance of Alpha Centauri, the nearest star. Ignoring the mass of Alpha Centauri let us call it a material point, then it has this velocity which is at a minimum, and its path is curved this way. This follows unless indeed, there is on the other side

of Alpha a Sun more massive than our own. If there is, then Alpha of the Centaur does not traverse a path of *regular* curvature. Neither does any other Sun owing to mutual attraction. Assigning to the nearest sun to ours a mass equal to the solar, assume our Sun to dwindle to a point, then *its* minimum velocity is 140 miles per hour.

Continuing research, let us recede to forty trillion miles, when we find that a mass there must move on an orbit ninety-nine miles per hour or fall toward the Sun. Seeking to escape solar gravity we sink in space to the appalling depth of 13,384 trillion miles, when behold! we still are dominated by his colossal power. Indeed! a sun at that distance of must fly on a gigantic curve five miles per hour or yield to solar force and fall. Or, having reached that point from infinite distance its falling velocity would be seven miles per hour. Light requires 2,880 years to traverse 16,384 trillion miles. But, a sun at that distance may not obey ours, its varying path may be determined by others nearer or more massive, and by none of these long at a time, since all suns shift position. Some suns are seen to move with greater velocity than theory demands, hence let us make further research in this exciting field.

NEW WINDSOR, ILL., January, 1885.

CAUSE OF SOLAR HEAT.

PROF. RICHARD A. PROCTOR.

Professor Young, of Princeton, in a recent address at Philadelphia, expressed his belief that the contraction theory of the sun's heat is the true and only available theory. I believe so, too, and my object in the present paper is to dwell upon the significance and interest of this remarkable interpretation of the solar mechanism.

Of course it is known to all that the old theory according to which the sun's heat is due to combustion ("doubt that the sun is fire," said Shakespeare, as if the doubt was the quintessence of absurdity) has long since been rejected as futile. A mass of the best combustible material, equal to the sun in quantity, would be burned out at his actual rate of emission—if it could burn right out—in about five thousand years. In like manner the idea of the sun as an intensely hot body simply radiating its heat into space, as a piece of white-hot iron does, without any process of combustion, has had to be rejected. Even if the sun were formed of matter possessing the high specific heat of water which has the remarkable property of giving out more heat in cooling than any other natural substance known (and only one or two artificial substances surpass it in this respect), even then the sun's emission of heat at his present rate would not cover more than about 5,500 years. Processes of chemical change have been suggested as affording the true source of solar heat; but they in turn have had to be rejected as altogether insufficient. It is unnecessary to touch on the supposed origin of solar heat in the

gathering in of meteoric bodies, for in reality this process belongs to the contraction theory; it has, however, been abundantly demonstrated that the actual amount of sun heat which could be derived from the drawing in of matter now outside the solar globe can be but very small. We are left, in fine, no recourse—so far as our present knowledge extends—but to regard the process of contraction taking place within the solar globe as the true source of all or very nearly all the heat and light which the sun emits, and therefore of every form of force and life on this earth and on whatever other members of the solar system may be the abode of life or a scene of the display of any forms of force not derived from internal heat and energy.

But now at the very outset, what a mighty mystery is thus unveiled! It seemed wonderful enough to recognize in what we fondly call inert matter the source of the energies which guide the heavenly bodies in their motions. I know indeed nothing more mysterious (more hopelessly mysterious, one might say, if one could limit the possibilities of future research) than the mystery of gravity. It has been said, and truly said, that

> Nature and Nature's laws lay hid in night,
> God said, "Let Newton be," and all was light.

All was indeed light where before men had been groping in darkness. But outside the region where they had thus been searching, far vaster regions of darkness were revealed. A veil was lifted and one of nature's mysteries was interpreted, but a more impenetrable veil was seen beyond, which as yet no man has even hoped to lift. What greater mystery can there be than this, that matter acts where it is not? The sun on the earth and all his planets, the earth on the moon, Jupiter and Saturn on their world systems, planet on planet, star on star, nay, every particle of matter on every other throughout infinity of space. And not only so, but time apparently annihilated as well as distance. For it has been shown that unless the force of gravity traversed distance with far greater velocity, nay, with many times the velocity of light (187,000 miles per second), the whole mechanism of the solar system would long since have gone wrong. Nor has it yet been shown how minute the time intervals are in which practical infinities of distance are traversed by this all-pervading attractive action.

And now we find that not only is "inert" matter thus intensely, one may say infinitely, energetic, as a cause of motion, but that it is the real source of the light and heat, which are in effect the very life of the universe itself. Within our own earth, the movements we call earthquakes, as well as all such disturbances as volcanic eruptions, geysers, and so forth, are all primarily due to the process of steady contraction taking place under the action of terrestrial gravity, though of course the proximate cause of each such disturbance is the heat generated during the process of contraction. In each planet, no doubt, similar processes are taking place, with greater or less energy according as a planet is younger or older. And now we see the mighty mass of the sun, steadily by its gravitating energy generating heat, whose emission is in fact the very life of the solar system. In other

words, there resides in mere matter, in what we have so long and so idly called inert matter, the real source of every kind of movement, of every kind of life, within the universe itself. For, what is true of our sun is true of his fellow suns, the stars; not only of the thousands we see, but of the tens, the hundreds of millions revealed by the telescope, and of the millions of millions of galaxies of suns which doubtless exist beyond the domain surveyed by our most powerful telescopes.

But, turning from this stupendous, one may truly say, this awful mystery, which seems to present gravitation as in a sense associated directly with the great first cause, we note that there are many minor mysteries about the theory that solar gravitation is the true source of solar heat.

In the first place, many find it difficult to understand how the shrinkage of even solid matter, still less that of vaporous matter, can lead to the generation of heat. Yet in reality, to any one who rightly apprehends the principle of the conservation of energy, it will be obvious that the heat generated as the solar gravity draws inward any portion of his envelope of vapors, and in so doing necessarily diminishes the volume of that portion, must be exactly the equivalent of the heat which would be required to reverse the process, and so to restore by expansion that portion of vaporous matter to its original volume. A real difficulty arises for a moment when we inquire why the heat generated momentarily by the forces tending to produce contraction is not momentarily employed in producing equivalent counter expansion. We must remember, however, that a portion of the heat generated must necessarily be radiated away into space, simply because it is exposed to the cold of space. One may compare the case to that of a pump so constructed that if all the water raised remained in a certian vessel round the place of exit, the weight of water would serve as a source of power to keep the pump working. In such a case, were friction entirely gotten rid of, the pump would work forever. But if the vessel were perforated so that all the time a portion of the water escaped, this would no longer happen. The heat constantly generated by the enforced process of solar contraction does in part escape; a portion continually undoes part of the work of contraction by causing expansion, but the portion which, as we see and feel, is continually escaping from the sun, causes a portion of the contraction to remain uncompensated. Thus the sun, as a whole, continues steadily contracting and steadily emitting heat. Nor will he cease to contract until he ceases to emit light and heat, or in other words, until he ceases to be the beneficent light-giving center of the solar system.

But the most perplexing mystery in connection with the contraction theory of the sun's heat is that the sun and the earth seem to tell a different story in regard to the amount of heat which has been poured forth. Judging from the sun's apparent size, it would seem as though not more than 20,000,000 of years of solar work, at the sun's present rate of working, could possibly have been done; for if he had gathered in his mass from any distances, however large, that would be the absolute maxim of energy represented by the process of contraction to his present apparent size. But the earth's crust seems to tell us of a much

longer period of sun work than this. If Dr. Croll, of Glasgow, whose results Sir Charles Lyell accepted, has rightly estimated the amount of work so done on the earth, it can not represent less than one hundred millions of years of sun work. How can we explain the discrepancy? Prof. Young accepts the sun's evidence as it stands, making only the provision that if in past ages the sun was exposed to some violent shock, as by collision with another sun, more heat would have been generated. Dr. Croll takes the earth's evidence alone, and considers that there must have been such collision. For my own part, I consider it clearly proved in other ways (and it comes in well to remove this particular difficulty) that the sun's real globe is very much smaller than the globe we see. In other words, the process of contraction has gone on further than, judging from the sun's apparent size, we should suppose it to have done, and therefore represents more sun work. According to this view, however, the sun's future would last many millions of years less than it would if his apparent size is not far from his real size. But the limited allowance of future work we should assign to him—a few millions of years' work at the outside—is estimated on the assumption that only such densities as we recognize in terrestrial substances can be attained within the sun's mass. It may well be that under the conditions there existing, matter may attain densities far greater than we find here. If so, the sun's duration as the life-giving center of a family of worlds may be far greater than has hitherto been supposed.—*New York Tribune.*

SUN AND PLANETS FOR FEBRUARY, 1885.

W. DAWSON, SPICELAND, IND.

The Sun's R. A. at noon, February 1st, is 21h. 2m.; and Declination 16° 54′ S., making the day about fifty minutes longer than December 31st, when the Sun's Declination was 23½° S. Spots on the Sun were few and small in the first half of January. Two pretty good-sized ones near east edge on the 17th.

The planet Saturn occupies pretty nearly the same place among the stars that it did in December and January—rather more west. Its retrograde motion continues very slowly till the 16th, when it assumes the eastern, or direct, motion of R. A. The ring is now about its widest and will continue so with little diminution for several months. It souths at 8:16 P. M. on the 1st, and at 6:30 on the 28th.

Jupiter rises at 7:00 P. M. on the 1st, some north of east. It is very bright and can easily be known from any other star. Regulus in the Sickle is a few degrees above this planet. They will be near together in latter part of March. Jupiter will be in opposition to the Sun on the 19th of February, and its motion is retrograde, which accounts for its approach to Regulus.

Any person having a telescope, or even a spy-glass, will be interested in observing this great planet with its moons and belts, now it is so near us in the

evening. Mars comes in conjunction with the Sun (on the other side) in the morning of the 11th.

Venus is still a low Morning Star away southeast. Mercury will be just south of it on the 11th. Uranus is still between Eta and Gamma Virginis. Neptune is nearly where it has been for several months, a few degrees southwest of Pleiades.

METEOROLOGY.

METEOROLOGICAL SUMMARY FOR THE YEAR 1884.

PROF. F. H. SNOW, UNIVERSITY OF KANSAS.

The most notable features of the year 1884, as observed at Lawrence, were the low mean temperatures of the spring, summer, and winter months; the high mean temperature of the autumn months; the very large rainfall, which came within half an inch of the extraordinary precipitation of the year 1876; the unusual percentage of cloudiness; the low velocity of the wind; the decided preponderance of south winds over north winds; and the increased percentage of atmospheric humidity.

TEMPERATURE.—Mean temperature of the year, 51.30°, which is 2.11° below the mean of the sixteen preceding years. The highest temperature was 98°, on July 8; the lowest was 21.5° below zero, on the 5th of January, giving a range for the year of 119.5°. Mean at 7 A. M., 45.69°; at 2 P. M., 59.40°; at 9 P. M., 50.04°.

Mean temperature of the winter months, 24.19°, which is 5.71° below the average winter temperature; of the spring, 51.41°, which is 2.41° below the average; of the summer, 73.05°, which is 3.05° below the average; of the autumn, 56 59°, which is 3.01° above the average.

The coldest month of the year was January, with mean temperature 20.99°; the coldest week was January 1st to 7th, mean temperature 0.07° below zero; the coldest day was January 5th, mean temperature 12° below zero. The mercury fell below zero fourteen times, of which seven were in January, one in February, and six in December.

The warmest month was July, with mean temperature 76.93°; the warmest week was July 20th to 26th, mean 79.66°; the warmest day was July 8th, mean 80.37°. The mercury reached or exceeded 90° on twenty days (one less than half the average number), viz., two in June, ten in July, three in August, and five in September.

The last hoar frost of spring was on April 24th; the first hoar frost of autumn

was on October 8th, giving an interval of 167 days, or nearly six months, entirely without frost. The average interval is 154 days.

The last severe frost of spring was on April 8th; the first severe frost of autumn was on the 23d of October; giving an interval of 198 days, or nearly seven months, without severe frost. The average interval is 199 days. No frost during the year caused damage to crops of grain and fruit. The low temperatures of January were generally destructive to peach buds.

RAIN.—The entire rainfall, including melted snow, was 43.70 inches, which has been but once exceeded on our seventeen years' record (in 1876) and is 9.05 inches above the annual average. Either rain or snow, or both, in measurable quantities, fell on 115 days—eleven more than the average. On nine other days rain or snow fell in quantity too small for measurement.

There was no approach to a drouth during the year, the longest interval without rain in the growing season being thirteen days, from July 30 to August 12.

The number of thunder showers was thirty-five. There was but one light hail storm during the year—on May 17th.

SNOW.—The entire depth of snow was 29 inches, which is 8.62 inches above the average. Of this amount twelve inches fell in January, two inches in February, one inch in March, six inches in April, one and a half inches in November, and six and a half inches in December. Snow fell on twenty-one days. The last snow of spring was on April 21st; the first snow of autumn was on November 18th—ten days later than the average date.

FACE OF THE SKY.—The mean cloudiness of the year was 47.56 per cent, which is 3.09 per cent above the average. The number of clear days (less than one-third cloudy) was 146; half clear (from one to two-thirds cloudy) 116; cloudy (more than two-thirds) 104. There were seventy-five days on which the cloudiness reached or exceeded 80 per cent. There were thirty-three entirely clear and forty-three entirely cloudy days. The clearest month was October, with a mean of 34.19 per cent; the cloudiest month was December, mean 66.34 per cent. The percentage of cloudiness at 7 A. M. was 53.89; at 2 P. M., 49.76; at 9 P. M., 39.03.

DIRECTION OF THE WIND.—During the year, three observations daily, the wind was from the south-west, 266 times; north-west, 252 times; south-east, 201 times; north-east, 197 times; south, 76 times; north 46 times; east 37 times; west 23 times. The south winds (including south-west, south, and south-east), outnumbered the north (including north-west, north, and north-east), in the ratio of 543 to 495.

VELOCITY OF THE WIND.—The number of miles traveled by the wind during the year was 131,188, which is 7,421 miles below the annual average for the eleven preceding years. This gives a mean daily velocity of 358.44 miles and a mean hourly velocity of 14.93 miles. The highest hourly velocity was 75 miles,

on June 25th; the highest daily velocity was 990 miles, on the 19th of January; the highest monthly velocity was 14,368 miles in January. The three windiest months were January, March, and April; the three calmest months were June, July, and August. The average velocity at 7 A. M. was 14.62 miles; at 2 P. M., 16.91 miles; at 9 P. M., 14.27 miles.

BAROMETER.—Mean height of barometer column, 29.111 inches, which is 0.006 inch above the annual mean. Mean at 7 A. M., 29.133 inches; at 2 P. M., 29.091 inches; at 9 P. M., 29.109 inches; maximum, 29.881 inches, on January 4th; minimum, 28.451 inches, on March 27th; yearly range, 1.430 inches. The highest monthly mean was 29.333 inches, in February; the lowest was 29.002 inches in April. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.—The average atmospheric humidity for the year was 72.6; at 7 A. M., 83.1; at 2 P. M., 55.8; at 9 P. M., 78.8. The dampest month was September, with mean humidity, 77.8; the dryest month was March, mean humidity, 65.0. There were twenty-eight fogs during the year. The lowest humidity for any single observation was 15 per cent, on March 12th.

The following tables give the mean temperature, the extremes of temperature, the number of inches of rain and snow, the number of rainy days, the number of thunder showers, the mean cloudiness, the relative humidity, the number of fogs, the velocity of the wind, the mean and extreme barometer heights for each month of the year 1884, and a comparison with each of the sixteen preceding years:

YEAR 1884.

1884.	Mean Temperature.	Max. Temperature.	Min. Temperature.	Rain—Inches.	Snow—Inches.	Rainy Days.	Thunder Storms.	Mean Cloudiness.	Mean Humidity.	Number of Fogs.	Miles of Wind.	Mean Barometer.	Max. Barometer.	Min. Barometer.
January	20.99	57.0	-21.5	1.28	12.0	7	0	41.42	73.9	3	14,368	29,313	29,881	28,735
February	28.03	57.0	- 1.0	1.13	2.0	8	1	54.33	72.3	1	11,651	29,158	29,469	28,587
March	41.56	73.0	12.0	2.73	1.0	9	5	58.87	65.0	2	14,229	29,054	29,465	28,451
April	50.42	76.5	28.5	5.62	6.0	13	4	55.76	65.9	1	13,954	29,001	29,321	28,495
May	62.24	85.0	36.0	3.57	0.0	12	2	50.54	68.9	2	9,978	29,046	29,299	28,689
June	71.07	92.0	48.0	3.81	0.0	12	7	38.78	71.8	1	6,806	29,065	29,270	28,831
July	76.93	98.0	60.5	5.18	0.0	15	5	41.67	71.7	1	8,733	29,004	29,289	29,809
August	71.14	92.5	47.5	5.49	0.0	11	4	48.16	77.8	3	9,392	29,110	29,405	28,849
September	70.36	92.0	48.0	9.15	0.0	8	5	40.00	76.3	3	11,409	29,037	29,404	28,810
October	57.87	85.0	31.0	2.38	0.0	8	2	34.19	74.8	5	10,150	29,179	29,568	28,712
November	41.53	70.0	9.5	0.80	1.5	3	0	40.77	72.0	5	10,503	29,175	29,563	29,634
December	23.54	59.5	6.5	2.56	6.5	9	0	66.34	80.0	1	10,015	29,189	29,666	28,618
Mean	51.30	78.1	25.4	3.64	2.4	10	3	47.56	72.6	2	10,932	29,111	29,467	28,685

SEVENTEEN YEARS: 1868—1884.

YEAR.	Mean Temperature.	Max. Temp.	Min. Temp.	Hot Days (above 90°.)	Zero Days.	Days between severe frosts.	Rain—Inches.	Snow—Inches.	Rainy Days.	Thunder Storms.	Mean Cloudiness.	Mean Humidity.	No. of Fogs.	Miles of Wind.	Mean Barometer.
1868.....	53.36	101.0	-16.5	43	7	160	37.48	27.50	77	.....	42.35	.....	.....	.....	.....
1869.....	50.99	96.0	- 5.0	23	2	167	38.51	18.00	105	33	49.23	78.2	19	.....	29.103
1870.....	54.50	102.0	-10.0	51	6	197	31.32	9.50	100	27	47.88	68.4	13	.....	29.097
1871.....	54.30	103.0	- 6.0	48	8	218	33.23	29.75	120	24	47.37	65.9	6	.....	29.076
1872.....	51.90	97.0	-18.0	45	16	192	32.63	23.25	116	40	44.33	64.4	11	.....	29.112
1873.....	52.71	104.0	-26.0	48	9	165	32.94	26 50	101	17	42.46	64.0	6	154,508	29.093
1874.....	54.20	108.0	- 3.0	58	2	187	28 87	43.00	99	20	45.54	65.7	14	145,865	29.121
1875.....	50.60	99.0	-16.5	32	12	196	28.87	5.00	106	21	44.81	66.7	5	145,316	29.102
1876.....	52.76	98.0	- 5.0	36	4	179	44.18	25.75	102	29	41.27	66.8	4	148,120	29.102
1877.	54.16	99.0	- 9.0	20	3	217	41.09	15.50	126	39	47.12	72.6	11	113,997	29.117
1878.....	55.33	98.0	- 6.0	35	7	228	38.39	25.50	107	38	40.65	70.2	5	125,793	29.067
1879.....	54.67	99.5	-16.0	48	13	203	32.68	10.35	90	36	40.01	67.1	10	124,758	29.127
1880.....	54.01	101.0	-12.0	41	2	211	32.65	7.00	89	29	40.15	67.9	18	146,039	29.123
1881.....	54.65	104.0	- 8.0	68	6	210	33.27	32.50	110	31	47.42	70.1	11	141,430	29.103
1882.....	54.94	105.0	- 6.5	40	1	232	27.60	18.00	102	26	45.41	68.6	14	137,736	29.113
1883.....	51.66	96.5	-14.0	26	8	217	40.65	12.50	106	32	45.24	69.7	18	141,164	29.135
1884.....	51.30	98.0	-21.5	20	14	198	43.70	29.00	115	35	47.56	72.6	28	131,188	29.111
Mean.....	53.29	97.8	-12.8	41	7	199	35.18	20.87	104	30	44.65	68.7	12	137,591	19.106

In the column of minimum temperatures a dash indicates temperature below zero.

CORRESPONDENCE.

THE NEW ORLEANS EXPOSITION.

EDITOR REVIEW:—The Christmas holidays gave our city teachers a much needed vacation, which was improved by about forty of us in visiting the New Orleans Exposition. Of course we went by way of the Memphis Short Line, with buffet sleepers the whole distance. As the ground was covered with snow and ice, and the mercury only barely above zero when we started, little can be said of the picturesqueness of the scenery, the charms of the climate or the verdure and productiveness of the soil along the route, either in Kansas, Missouri or Arkansas. At Memphis we found the Mississippi full of heavy floating ice, and from that city for the greater portion of the way to New Orleans old winter had locked everything up in icy bonds, so that so far as appearances went the "Sunny South" had fully acknowledged his sway. A few holly-trees, some pines, some canes, and, as we approached the Gulf, some magnolias and live-

oaks, retained their green foliage, otherwise all the trees were as bare of leaves and the grass as dead as in the North.

Cotton fields here and there, half picked, broke the monotony of dense forests and canebrakes; farm houses and cabins showed themselves at long intervals; towns and villages were almost unknown; the railway stations were mostly single shanties without even the accompaniment of the universal saloons and eating houses; animal life was scarce, and as for people, it was a wonder, as one of our professors said, where the South, if this was a sample of it, found the men to make the resistance it did to the march of our armies in the late war. The morning of our arrival in New Orleans found us amid sugar plantations, orange groves, blooming roses, well advanced gardens, barefooted negroes and other signs of a tropical climate. The weather was warm, but the air was moist and murky.

About 9:00 o'clock we rolled into the city, passing over miles of low, flat, swampy outskirts with grassy streets cut into miry channels by the teams plunging through them. On the right we could see the Exposition buildings in the distance, with the chimneys and even the hulls of the steamers on the river beyond looming up high above the intermediate territory. On the left more swamps with palmettoes, moss-burdened oaks and cypresses, and tangled vines, extending clear to the margin of Lake Ponchartrain. In front, mud, smoke, white frame houses with enormous double porticoes, negroes, oranges, bananas, French women, blooming dooryards with high close fences, and ditches full of filthy water, made up the landscape. At the depot we took carriages and omnibuses and were jolted to our hotel over the roughest streets imaginable. If any one of our readers was ever sick while in the army and compelled to ride in a government wagon over the corduroy roads of Virginia, he will have a pretty good idea of this closing ride, otherwise he cannot, as nothing else ever equaled it for discomfort. The paving of the streets, where any has been done, consists of blocks of stone of uneven sizes and shapes, with—apparently—an omission of every other one.

While growling, I may as well say that if disease really does ever come from dirt there should not be a well ~~known~~ person in New Orleans at present, for it is impossible to conceive of streets more utterly foul and filthy. Not only is there an unmeasureable vastness of mud, hardly barred off from the sidewalks by the curbstones, and swashed along sluggishly by the oozy torrents in the gutters, but every butcher, baker, saloon-keeper, etc., who has a bucket of slops to dispose of brings it to the edge of the sidewalk and pitches it into the middle of the street. You have mud in Kansas City, but it is so clean compared with New Orleans mud that you could absolutely cleanse yourself in it after wading about in the latter for an hour or two. Inasmuch as I learn that this city is quite healthy now, I am prepared to discard the theory that dirt has anything to do with originating disease, and propose to protest against our Dr. Fee's sanitary precautions as unnecessary and possibly baneful.

Having said so much in disparagement of this city, I will now say something

to its credit. I had heard much of extortionate rates for rooms, board, meals, etc., but after a week's stay I can candidly say that I have found nothing of the kind. The hotel charges remain as formerly, from five dollars a day down to two and one-half, according to style, location, etc. No one need pay out more than three dollars per day for very comfortable living, with room to himself and meals at a French restaurant. With economy and by doubling up in rooms, this figure can be considerably reduced. One can go out to the exposition grounds—four miles—on a steamboat at twenty-five cents for the round trip, landing at the side entrance to the grounds, or on the street cars for five cents each way, getting off at the main entrance. He can ride out to Lake Ponchartrain on the steam cars by two routes, five miles or more, for twenty cents the round trip, or he can, if he is as lucky as the teachers of the northwest, take an excursion to Mobile and back, with a stop at Jeff. Davis' place, Beauvoir, and a fish dinner at Pass Christian, for two dollars; or he can take a steamer down to the Jetties and back with a sail on the Gulf, for six dollars, including berth and meals on the boat for twenty-four hours; so that you see the rates are not so very exhorbitant after all.

As to the city, it is much like all other cities. Among its curiosities are the old French town and the French market, the levee with its shipping from all parts of the world; its cotton exchange, its shot tower, cathedral, etc.

Now for the Exposition. So much has been written about it that one hardly knows what to say that will be new. Everybody knows that it is located on the flats above the city, and that one hundred and seven acres are inclosed for its uses and purposes; that the main building covers thirty-three acres of ground, and that about two millions of dollars have been expended upon it and the other buildings. These things are well known and yet the people who know them may not realize how large this main building is. It might astonish some of them to appreciate the fact that it is as large square as from 8th to 12th Street in Kansas City, or that the music hall, large enough to seat 11,000 persons on one floor, may be passed unnoticed day after day, although nearly in the center of the building, if you happen to enter by any other than the grand front door. Constructed of glass and iron, it is both light and strong, and as a grand architectural work it is an admirable and marvelous success. It, as well as the government building, is the work of a Swedish architect named Torgerson.

The management of the whole affair, from its conception to the present day, has been concentrated in the person of Major A. E. Burke, editor of the *Times-Democrat*, of New Orleans. He has done in less than one year and with $2,000,000, what the Philadelphians were glorified for accomplishing in four years with more than three times as much money. He has put his whole soul into it and, for that matter, his body too, for he has worn himself out more in these few months than he would have done in ordinary business in as many years. As a man who knows something about expositions, in a small way, I pronounce the management of this New Orleans affair a wonderful success. The delays and hindrances are less noticeable than usual, in proportion, and are due far more largely to the lethargy of the citizens of the city and of the people of the South,

who are chiefly to be benefitted by it, than to any other cause. They could and should have put their money into it liberally; at least they should have paid up their voluntary subscriptions—and not have allowed its credit to be destroyed before its completion; they should have provided better means of access, both for freight and visitors, and they should patronize it better themselves.

But even as it is, it is a better exposition in many respects than this country ever saw. Any visitor who undertakes to see all that is even now well presented —omitting all unfinished exhibits—in one week will fail to do it justice. Any visitor who is interested in any special subject and desires to study it in detail, can spend days on that alone, whether it be ores, minerals, products of the soil, manufactured articles, natural history, archæology, machinery, inventions, art, educational facilities, or progress and results in any other line. Every State and Territory is fully and excellently represented in all these respects, and while some few are yet in an unfinished condition, it is the verdict of all who visited it that these exhibits far excel in size and manner of arrangement those at the Centennial at Philadelphia in 1876. To be personal and candid, I will say that Nebraska seems to take the lead of all in the magnitude and the tastefulness of her display, while Kansas comes next. Missouri has a striking array of packing-boxes, barrels, bales, etc., besides a quantity of freight yet remaining at the depots, which when arranged as contemplated will be highly creditable to Major Hilder and his assistants. Of course the $2,000 or $3,000 raised for this purpose, mainly in St. Louis, will not enable them to make much of an effort to compete with States whose legislatures and private citizens furnished their commissioners with from $5,000 to $25,000 to give an adequate representation.

The display by the Interior and other departments of the Government is absolutely superb, and one who has not visited the Patent Office, Smithsonian Institution, Bureau of Education, Coast Survey, Signal Office, Agricultural Department, Post Office Department, National Museum, Fish Commission, etc., will be fully repaid by these alone for a trip to New Orleans. I am not certain that he will not be better satisfied here, because he can see the best items of all these collections, all under one roof, and thus avoid the fatigue of looking them up in buildings scattered all over Washington City.

If he has a taste for natural history, not fully gratified by the specimens in the Government and State displays, he can step into the gallery and there find the vast collection of Prof. H. A. Ward, of Rochester, which is unequaled in the country. In this he will find restorations and casts, life-size, of the mammoth or fossil elephant, the *Glyptodon clavipes*, the *Megatherium*, the *Mylodon robustus*, and the Irish Elk, besides skeletons, beautifully articulated and mounted, of man and all the Simian family, side by side; birds, fishes, reptiles, etc. Many of these cannot be seen elsewhere in the United States, and Prof. Ward has never before drawn so largely upon his museum for an outside exhibition.

In the main building other nations besides the United States are represented, such as Mexico, Turkey, Honduras, Japan, etc.

To those who are fond of machinery we commend Division B, an iron exten-

sion of the main building, 600x220 feet, filled with machinery for picking, ginning and pressing cotton and also wood-working machines; beyond this another vast room 600x60 feet for heavier machinery, such as saw-mills, etc. Adjoining this, in the main building, are found all kinds of milling machinery; also the exhibits of the Willimantic, Coates, Clark, and Whitin spool cotton companies; the first-named occupying seventeen spaces, or about 200 feet, with the various machines employed in manufacturing spool thread, all in full operation, with crowds of interested spectators watching the successive processes the cotton passes through, from the raw staple to the spooled thread. Near by are the Corticelli Silk Company's headquarters, where can be seen everything connected with the manufacture of spool silk, from the silk-moth, the egg, the silk-worm the cocoon, the reeling of the silk from the cocoon, the spinning, winding, the to coloring, spooling, etc.

Going back to the machinery, we find nearly in the center of the main building the motive power which keeps all the other machinery, as well as the dynamos for the electric lights and electrical display in motion. Principal among these engines is the huge Corliss engine set in operation on the opening day by an electric signal from President Arthur from his room in the White House; but there are nearly a dozen others, aggregating over 4,000 horse-power, grouped together in that locality. Near these is a wonderful display of sugar machinery, railroad engines and cars of all kinds and other heavy machinery, including some very old-fashioned locomotive engines and an electric railway of the most recent date. The ice machines are by no means the least interesting objects, especially to the people of the south, and there are specimens of several patterns, besides refrigerators in all styles and sizes.

In agricultural machinery the display is comparatively light, and I think that I have often seen more of all kinds on exhibition at the Kansas City Expositions.

The electric light is a success. Most of the principal companies of the country are employed to furnish light, such as the Brush, the Edison, the Fort Wayne, and a home company. Thousands of electric lamps, inside and outside of the buildings, give ample light for all purposes, so that visitors who can not go out in the day time can see just as well at night. The Brush Company have the lighting of the government building where the National and State exhibits are displayed, and employ six of their largest dynamos for generating the electricity needed for the 3,600 lights furnished. The Edison Company light the Main Building and Agricultural Hall with over 4,000 incandescent lamps, and have twelve dynamos operated by six engines of 125 horse power each, with a capacity of over 6,000 lights. When the Art Hall is finished this company is to light that also. The Fort Wayne Company light the outside towers—about ten in number—including those at the entrance to the grounds and buildings, also the sheds, stables, etc. These towers are very handsome, being light, ornamental in appearance, and very strong. One of them, placed at the "Lake," is of 100,000 candle power—said to be the largest single electrical light in the world. The home

(Louisiana) Company furnish 800 arc lights in the Main Building. Collectively, this electric system is the largest ever in operation.

Among the myriads of objects of interest, one which attracted my attention and excited my interest, was a white bronze statue, about fifteen feet high, of a private soldier on his post, musket in hand, intended for either street, park, or cemetery purposes. It is admirably done, both in conception and execution, and I should like to see it placed on one of our principal crossings—say at the junction of Main and Delaware streets, at Ninth. It would be an appropriate thing for our citizens and the Grand Army to do, and it can be done for not exceeding $2,000.

Among the things for which Missouri may claim credit, is the time ball, constructed and put in operation by Professor H. S. Pritchett of Washington University, St. Louis. Every day at 10 A. M. this ball is dropped from the principal tower of the Main Building, the closing of the circuit being made by the standard clock at the observatory of Washington University, 700 miles away, to the exact fraction of a second in correctness. All the clocks in the building are kept uniform by the same signal.

Two of the States, viz., Florida and New Hampshire, present topographical models of their surfaces and shapes on a very large scale—perhaps fifteen by thirty feet—so that most of their physical features can be readily seen at a glance, while all of the States have most complete collections of their peculiar natural and artificial productions, artistically displayed.

The ethnological displays made by the Geological Bureau are most interesting, and include, as stated in the last issue of the REVIEW, products of aboriginal art, both ancient and modern, such as textile fabrics, pottery, implements of war, and the chase, and other curious objects connected with their religious ceremonies and festivities. The models of the Cliff-dwellings and of the pueblos of prehistoric and existing tribes from New Mexico, Colorado, and Arizona, are intensely interesting, and are constructed on a scale large enough to give a very fair idea of their architecture and other details. The Mound-builders, also, are fully represented by series of their implements, tools, ornaments, and other works, as well as by models of some of the most noted mounds and earth-works in the country. In fact, the $300,000 appropriated by Congress to enable the various departments of the Government to make fitting and useful exhibits at this Exposition, seem to have been most judiciously expended, and no one can fail to be gratified and satisfied with them, no matter in what subject illustrated he may be most interested.

Next month (February) doubtless everything will be in perfect order, so that then will be the most favorable time to come here, and the weather will probably be more propitious, for at present overcoat and fan are alternately and equally in demand.

C.

BOOK NOTICES.

THE BOOK OF ALGOONAH: Pages 353. Cyrus F. Newcomb & Co., Del Norte, Colorado, 1884. Cloth, $2.00.

This book is given to the public with a view of throwing light on a very interesting but obscure subject. The author admits that it will probably excite a great deal of honest criticism, but claims that it contains internal evidence of its authenticity as an historical book, and assures his readers that it is formed from authentic materials. It undertakes to point out the origin and career of the Mound-builders, designates "Algoonah, their first king, describes their formation as a nation, their home in the borders of Egypt, their travels through India, Tartary, and China to the Japan Islands, their exploration of Mezzinaroth (America), their settlement of Mexico and Central America, the history of this wonderful race and their landing on this continent, etc."

Being written in scriptural and allegorical style, it is difficult to follow the writer's idea at all times, but we recommend all archæologists to examine it with care.

CATARRH, SORE THROAT AND HOARSENESS: By J. M. W. Kitchen, M. D. Illustrated. 12mo, pp. 80. G. P. Putnam's Sons, New York, 1884. For sale by M. H. Dickinson, $1.00.

This little work comprises a description of the construction, action, and uses of the nasal passages and throat, certain diseases to which they are subject, and the best methods for their prevention and cure. Dr. Kitchen is the author of another work of a similar character, entitled "The Student's Manual of Diseases of the Nose and Throat," which has been highly commended, and he has filled and is now filling several positions in the New York hospitals and colleges, which eminently fit him to write from experience upon such subjects. The descriptions are accurate, and the suggestions for treatment sensible and based upon logical grounds and practical experience. Besides instructions for home treatment of these diseases, many of the latest instruments for professional treatment are described and illustrated, with hints and suggestions for physicians.

REPORT OF THE CHIEF SIGNAL OFFICER FOR 1883: General W. B. Hazen, U. S. Army, octavo, pp. 1164. Government Printing Office, 1884.

This ponderous volume contains the report proper of the Chief Signal Officer, which occupies but eighteen pages, and the appendix, charts, etc., which are the meteorological statistics gathered from stations all over the country, the reports upon the Lady Franklin Bay Expedition, and the Relief Expedition to Point

Barrow in 1883, outline of the lectures delivered to the Signal Service Corps of students at Fort Meyer, etc.

General Hazen deplores the reduction in the appropriation for weather observations as being detrimental to the interests of the people, alleging that the demands of the country upon the Signal Service are greater than ever before, and showing the value of the weather statistics and predictions by the verifications of the latter on sea and on land. The percentage of accuracy in predictions has increased from 84.4 per cent in 1882 to 88 per cent in 1883, and of course this accuracy will still increase with any increase of stations.

In fifty-four cities, meteorological committees, to act in concert with the Signal Service, have been appointed. The popular idea that the rainfall on the Western plains has increased with the increase of railway and telegraph lines, has been exploded by careful and special observations by skilled observers and plans for systematic collection of data concerning tornadoes have been made, which observations may be of service upon being classed and generalized.

WISCONSIN HISTORICAL COLLECTIONS. Vol. IX, 1880–81–82: Wisconsin Historical Society, Madison, Wis., 1883. Octavo, pp. 498.

The energetic and capable Secretary of the above-named society, Professor Lyman C. Draper, in collecting and editing this series, is doing an important and valuable work for the State. It consists of articles upon the archæology, the early history and the progress of Wisconsin, with biographical sketches of some of its best men, such as Governor E. B. Washburn, Col. Larrabee, Judge Barron, and others. It is just such work as every State should secure before it is too late, and one which will be more and more highly appreciated as time passes.

PROGRESSIVE MORALITY: By Thomas Fowler, LL. D., F. S. A., President Corpus Christi College, Oxford. Price, post-free, 15 cents. J. Fitzgerald, Publisher, 20 Lafayette Place, New York. For sale by M. H. Dickinson.

The progress of Natural Science has been not without effect upon the data of the moral and intellectual sciences. The present work, by an author of the highest eminence, is an attempt to show wherein the principles of moral conduct are reinforced or explained by the application to Ethics of the methods of research employed in the study of nature. The author aims to present a scientific conception of Morality in a popular form, and with a view to practical application rather than to discuss theoretical difficulties. His views are in full harmony with those which, making exception for a few back eddies in the stream of modern thought, are winning their way to general acceptance among the more instructed and reflective men of our day.

OTHER PUBLICATIONS RECEIVED.

Annual Report of Missouri River Commission for 1884, from Prof. G. C. Broadhead. Meteorology of the Mountains and Plains of North America, as affecting the cattle-growing industries of the United States, by Capt. Silas Bent. *Tidings from Nature*, January, 1885, Vol I, No. 5, Rutland, Vermont. Reports from Consuls of the United States on Commerce, Manufactures, etc., No. 47, October and November. 1884, Washington, D. C. John Hopkins' University Studies. Herbert Adams' Editor, 3d Series. Maryland's Influence on Land Cessions to the United States, by Herbert Adams, Baltimore, Md., January, 1885, 2d Series. Land Laws of Mining Districts, by Charles H. Shinn, A. B., December, 1884. *Humboldt Library, No. 63.* Progressive Morality. An Essay in Ethics, by Thomas Fowler, M. A., J. Fitzgerald, 20 Lafayette Place, N. Y., 15 cents. Signal Service Notes, No. 15: Danger Lines and River Floods of 1882, by H. A. Hazen, Washington, D. C. Circulars of Information of the Bureau of Education, No. 6, 1884, Washington, D. C. *Humboldt Library, No. 64.* The Distribution of Life, by Alfred R. Wallace and W. T. T. Dyer, 15 cents, J. Fitzgerald & Co., N.Y. The Line of Florida Railway and Navigation Company, Benjamin S. Henning, President, General offices Fernandina, Fla. Illinois Central World's Exposition, compiled by Miss Lydia Strawn. *Journal of Microscopy and Natural Science*, edited by Alfred Allen, January, 1885, Vol. IV, Part 13, 1 Cambridge Place, Bath, England. Proceedings of Boston Society of Natural History, Vol. XXII, Part 4, October, 1883, and December, 1883, Boston, Mass. *The Woman's Magazine*, Esther Housh, Editor, Frank E. Housh, publisher, Brattleboro, Vt., Vol. VIII, No. 5, January, 1885, monthly, 10 cents, $1 per annum.

SCIENTIFIC MISCELLANY.

RECENTLY PATENTED IMPROVEMENTS.

J. C. HIGDON, M. E., KANSAS CITY, MO.

APPARATUS FOR LOADING CARS WITH COAL, ETC.—This invention has for its object the provision of improved means whereby box-cars and stock-cars may be readily loaded with coal or the like without the intervention of hand shoveling.

The apparatus consists principally in applying to the delivery or lower end of a coal chute a shunting-apron that is capable of being reversed or swung

around in a horizontal plane for the purpose of guiding the descending current of coal toward either end of the car, as may be desired.

The apron is constructed upon the plan of a quadrant, or quarter-circle, preferably of boiler-plate, and it is connected at or near its radius point to a rod extending laterally from the sides of the chute beneath the bottom thereof.

A hinge-piece is pivotally attached to the under side of the apron by means of a rivet or bolt.

The apron is provided upon its circumference with a raised flange corresponding in height to the chute side. This flange has upon its upper edge an aperture raised portion in order that a supporting chain may not come in contact with the chute sides. The upper end of the chain is attached centrally to a cross-bar of the supporting frame, and its lower extremity carries a hook which may engage any desired link of the chain for the purpose of adjusting the apron in relation to the chute bottom.

When the apron is in proper position the current of coal descending the chute will come in contact with the interposed flange and be thrown toward one end of the car, but when it is desired to fill the opposite end, a fastening bolt which passes through an aperture in the outer corners of the flange and through a corresponding aperture in the sides of the chute, is withdrawn, then the apron is swung around (the hinge sliding upon the rod) to a reverse position.

When the apron is not in use, it may be swung inwardly from either side toward the chute, entirely clear of passing cars.

The above described apparatus has been patented by Mr. A. Chadwick, of Kansas City.

PREHISTORIC STATUES.

An official communication received at the Navy Department announces the discovery on Rapanni, or Easter Island, on the charts in longitude 110° west and latitude 27° south, buried in the depths of the vast wilderness of waters of the South Pacific, of colossal statues and images rudely carved in stone. This remarkable find of archæological remains on a small island hundreds of miles away from any continent puzzles the learned scientists of the Smithsonian Institution and the National museum. Prof. Baird says on the subject: "In the present advanced state of ethnological science these monuments are of the highest importance. They will throw light on the somewhat mysterious manner in which this island receives its population."

The discoveries of these remarkable remains of a prehistoric and an advanced people in part of the world synonomous with cannibalism and savage life were the officers of the German gunboat Hyena, while on a trip from the Valparaiso to the Samoan Islands. The commander of this vessel, while thus cruising in the South Pacific, subsequently received orders from his government to visit Easter Island and secure these specimens. The accounts received by our government indicate

that the vessel remained at the island but a few days, but during that time the German officers made a considerable collection and copious notes. The results of their preliminary labors have been embraced in a pamphlet, which is reported at the Smithsonian Institution to contain a large amount of valuable information. The German government, it is understood, are making preparations to send an expedition to Easter Island with a corps of scientists and engineers to search the island, survey the ground, and to make plans and sections of the prehistoric buildings and ruins.

Our own government has also taken steps to secure some of these valuable remains for its large and valuable ethnological collection representing the prehistoric and known races of this hemisphere. Instructions have already been sent to Admiral Upshur, in command of the South Pacific squadron, to send one of his vessels on a cruise in the direction of Easter Island and to make such explorations, collections and reports as he may think important in the interests of the government. It is understood that the government of France is also turning its attention to this island with a view to the establishment of a protectorate.

It is reported in the accounts by the German vessel that the island, which is small, is strewn with large stone images and sculptured tablets. The Smithsonian has offered $1 each for prehistoric skulls with the lower jaw. The few people of Polynesian extraction who inhabited the island, know nothing about the sculptured remains found, and even tradition gives no account of a people living there when their ancestors arrived.

EDITORIAL NOTES.

PROF. RILEY, United States entomologist, has just received from George Cadell, Esq., Secretary of the International Forestry Exhibition at Edinburgh, the first gold medal awarded to him, it being the only gold medal awarded by the Exhibition managers to an American. The medal is large and handsome, with the words, "International Forestry Exhibition, Edinburgh, 1884." The reverse side has a wreath on a polished face with the words, "Awarded to Professor Riley, Washington, for Collection of Insects Injurious to Forest Trees."

MRS. JULIA SMITH, widow of the late Professor J. Lawrence Smith, of Louisville, Ky, has caused to be prepared for distribution among scientists and friends of the family, a very handsome memorial volume containing an account of his life, the honors conferred upon him in this and foreign countries, and a number of articles upon chemistry and mineralogy, written by him at different periods during his life. Professor Smith was a laborious investigator and an able writer, and the volume is a fitting tribute to his memory from one who knew him best.

WITH the mercury from 10° to 50° below zero in different portions of the country, earthquakes in Spain and elsewhere, avalanches in the Alps, universal snow storms and fierce winds, January, 1885, made a reputation for itself that will not soon be exceeded or forgotten. The 22d especially, was a notably cold day, the thermometer marking from 8° to 52° below zero in all the Northern States, from Kansas to New Hamp-

shire, while the cold was unprecedented in Arkansas, Louisiana, Texas, and other Southern States. Fifteen days steady sleighing in one month is an unusual record for Kansas City, while in the country adjacent it has been good for most of the time for nearly six weeks.

WE call attention of our readers to the article of Professor Bassett upon the Crawfordsville (Indiana) crinoids as containing some facts not ordinarily known. He has been engaged for many years in studying these remarkable fossils under the most favorable circumstances, and for two or three years has made a business of supplying them to museums and public and private collections. Doubtless he is better acquainted with the subject than any man in the West. We have had the pleasure of seeing his best specimens and can testify to their beauty and perfection.

WE are glad to be informed that the differences between the State Board of Health and the Hospital Medical College of this city have been adjusted, and that this institution is now placed upon the same footing as our other medical colleges, so that its graduates will hereafter be entitled to full recognition everywhere.

PROFESSOR S. H. TROWBRIDGE, of Glasgow, Mo., writes thus pleasantly of the REVIEW: "It is and has been from the start a grand success from a literary, educational, and scientific standpoint, and richly merits and should have equal success in a financial sense."

THE time for applications for space in the International Inventors' Exhibition, to be opened in London, in March, has been extended to February 10. The Exhibition will continue for about six months, and will be presided over by the Prince of Wales.

Division 1. (Inventions) will be devoted to apparatus, appliances, processes, and products, invented or brought into use since 1862, and illustrations thereof.

Division 2. (Music) will consist of examples of musical instruments of a date not earlier than the commencement of the present century; and of historic collections of musical instruments and appliances, and paintings, engravings, and drawings representing musical subjects, without any restriction as to date.

MR. EDGAR C. SAUNDERS, of Camp San Saba, Texas, sends us several nodules of sulphuret of iron which, he says, "lie upon a stratified formation of limestone and cover an area about three miles long by three-fourths wide." He notes their resemblance to meteorites and desires to know their origin, whether they have fallen out of the limestone in weathering, or whether they may be really meteorites.

WE learn from Secretary E. E. Richardson's 14th Annual Report of the Kansas City Stock Yards that during the past year the total shipments were: 533,992 cattle, 1,724,287 hogs, 237,214 sheep, 27,092 horses and mules, and that for the fourteen years since the opening of the yards 12,427,422 head of stock have been received and shipped.

THE Leavenworth Academy of Science at its last meeting elected the following officers for 1885: Hon. H. M. Aller, President; Prof. F. A. Fitzpatrick, Vice-President; Dr. R. J. Brown, Secretary, and Dr. T. Sinks, Treasurer. A resolution in favor of a State geological survey was passed and a committee appointed to present the matter to the Legislature this winter.

A committee of the National Academy of Science has replied to inquiries made by the joint committee of Congress on the proposed consolidation of the various scientific bureaus, by presenting a plan for the division of scientific work now performed into four bureaus, as follows: 1. The present coast and geodetic survey to continue. 2. The geological surveys as at present. 3. The meteorological bureau, to which should be

transferred so much of the present personnel and functions of the chief signal office as are not necessary to the military duties of that office. 4. A physical observatory to investigate the laws of solar and terrestrial radiation and their application to meteorology, with such other investigation in exact science as the government might assign to it

In this connection they suggest that the standard weights and measures be transferred to this bureau, and that the proposed electrical bureau be also included.

A bill has passed the House authorizing the building of a bridge across the Mississippi at Memphis. It is provided that two of the spans shall be not less than 550 feet in the clear; no span shall be less than 300 feet, and the height of the superstructure shall be 65 feet above extreme high water mark.

It is stated that extraordinary discoveries of silver have been made in the Cohuttah Mountains in Northern Georgia, by a Boston company. They claim to have traced a vein of 1,500 feet extending easterly through the mountain, a distance of eight or nine miles The assays run as high as eighty per cent.

The total enrollment of students at the University of Kansas for 1883-4 was 521, as against 582 for 1882-3. The apparent falling off is explained by the Regents in their report as having been caused by the discontinuance of the lowest preparatory class, which in 1882-3 numbered 125 members. They recommended an appropriation of $50,000 for the erection of a building for the Department of Natural History.

The State Historical Society met in annual session at Topeka, Kansas, January 20. Officers were elected for the ensuing year as follows:

President—D. R. Anthony, Leavenworth.

First Vice-President—B. F. Simpson, Paola.

Second Vice-President—S. N. Wood, Topeka.

Secretary—F. G. Adams, Topeka.

Treasurer—John Francis, Topeka.

The number of directors was increased from forty-eight to ninety-nine, and elected in classes for one, two, and three years.

The retiring president, Mr. F. P. Baker, and M. W. Reynolds delivered addresses.

At the annual meeting of the St. Louis Academy of Science, the following named gentlemen were elected officers for the present year: Prof. F. E. Nipher, President; Dr. Leete, First Vice-President; M. L. Gray, Second Vice-President; Dr. Evers, Corresponding Secretary; Prof. Engler, Recording Secretary; Dr. Sander, Treasurer; Prof. Hambach, Librarian. Mr. Alderdice, Dr. Luedeking and Prof. Hambach were elected Board of Curators.

A company known as the Natural Gas Company has been boring for some weeks at the foot of Third street, in West Kansas City, for gas, and recently struck it in considerable quantity. They claim a pressure of one hundred pounds to the square inch and a capacity of eighty thousand cubic feet per day, and announce their intention of immediately sinking two more wells. If their claims are well founded we may expect to see the manufacturing interests of Kansas City take an immense forward stride at once.

At a meeting of the Anthropological Society of Washington City the following officers were elected for the ensuing year: President, J. W. Powell; Vice-Presidents, Dr. Robert Fletcher, Prof. L. F. Ward, Col. Garrick Mallery, Prof. O. T. Mason; Secretaries, S. V. Proudfit, F. A. Seely; Treasurer, Prof. J. H. Gore; Curator, W. J. Hoffman; Members of Council, H. H. Bates, Dr. Frank Baker, Rev. J. O. Dorsey, W. H. Holmes, David Hutchinson, Prof. Cyrus Thomas.

ITEMS FROM PERIOICALS.

Subscribers to the Review *can be furnished through this office with all the best magazines of this Country and Europe, at a discount of from* 15 *to* 20 *per cent off the retail price.*

To any person remitting to us the annual subscription price of any three of the prominent literary or scientific magazines of the United States, we will promptly furnish the same, and the KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY, *besides, without additional cost, for one year.*

WHETHER we agree with Mr. Beecher or not, few men can speak or write on any subject of public interest with so great a certainty that everybody will want to know what they say. In discussing the question as to how far ministers may properly go in politics – which he does in the *North American Review* for February—the great preacher shows himself to advantage perhaps all the more because it is a matter that touches him personally as well as professionally. In the same number of the *Review*, the question, "How shall the President be Elected?" is ably treated by five happily chosen writers, viz., two United States Senators, Dawes and Vance; a college president, F. A. P. Barnard, of Columbia; a New York lawyer, Roger A. Pryor, and a well-known journalist, William Purcell. The substantial agreement of four of them on the same point is significant. Another notable article in this unusually strong number is a review of "Holmes's Life of Emerson," by the veteran historian, Geo. Bancroft; and still another is an essay by Prof. C. A. Young on "Theories regarding the Sun's Corona," which he skillfully brings within popular comprehension. The Rev. Dr. W. G. T. Shedd defends the dogma "Endless Punishment," and Prof. G. Stanley Hall writes on "New Departures in Education."

WE suppose that we are in debt to Mr. William Hosea Ballou, of New York, for the following flattering notice in the *Saturday Evening Herald* of Chicago: "The KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY is perhaps the only successful monthly west of New York. When literary monthlies find an uncongenial soil in the West, it is all the more remarkable that a high-toned periodical, devoted exclusively to science and requiring seventy 8vo pages for each issue, should grow and thrive. THE REVIEW is almost in its ninth volume. Its contributors are mainly Western men who have conferred a lustre on the unlimited scientific research of the vast prairies and vaster mountain ranges. This successful exponent of class journalism is entirely the work of its able editor, Mr. Theodore S. Case."

WE find in the Boston *Literary World* the following appreciative notice of a new book compiled and arranged by Messrs. Fulton & Trueblood of this city: "The distinctive features of Fulton & Trueblood's volume of selections for readings, 'Choice Readings from Standard and Popular Authors,' are the abundance, variety, and excellence of the selections themselves, the prefixed diagram of the elements of vocal expression, showing the different kinds of thought embodied therein, the representation of the seven great orators of the world, the scenes from popular dramas, and the appended descriptive indices to selections from Shakespeare, the Bible, and Christian hymnology, suitable for public use. The collection is unusually rich, dignified, and suggestive."

WE have received the first number of the *Journal of Mycology*, published at Manhattan, Kas., and edited by Prof. W. A. Kellerman of the Kansas Agricultural College, assisted by J. B. Ellis of Newfield, N. J., and E. M. Everhart, of Westchester, Pa.

It is a neat little magazine of sixteen pages, and will be devoted to mycological botany, special attention being given to the North American fungi. It will aim to be the organ of students of this branch of botanical science, and as such deserves the patronage of all persons interested in it. Monthly, $1 00 per annum.

DURING 1885, subscribers to the *Art Interchange* will receive thirteen (13) full-page colored supplements, some double size; twenty-six (26) extra pattern supplements, containing over one hundred full-size outline artistic designs, ready for tracing, applicable to all the varied branches of art work.

Hundreds of illustrations of other art objects, which are suggestive examples most useful to amateurs and art workers. These can not be procured in any other way. A number of large art supplements, which are reproductions of the most attractive master-pieces. These are printed in the best manner, on fine heavy paper, and are suitable for framing or for portfolio. In all, an actual return of exclusive designs and art material worth two hundred dollars ($200) or more, for $3 per annum.

It is always a pleasure to receive the *Atlantic Monthly*. The February number is especially interesting. We give its contents herewith: A Marsh Island, IV–VII., Sarah Orne Jewett. Winter Birds about Boston, Bradford Torrey. Spirit of Spirit, Edith M. Thomas. Madame Mohl, her Salon and Her Friends; second paper, Kathleen O'Meara. A Sheaf of Sonnets, I Ellen Terry's Beatrice; II The Resolve; III On First Reading Landor's Hellenics; IV Bach's St. Matthew Passion Music; V The Passing of the Year, Helen Gray Cone. The Prophet of the Great Smoky Mountains, II., III, Chas. Egbert Craddock. The Quest for the Gral of Ancient Art, William Shields Liscomb. Vernon Lee, Harriet Waters Preston. A Country Gentleman, IV–VII M. O. W. Oliphant. The New Portfolio, II Oliver Wendell Holmes Strange, E. R. Sill. Nathaniel Hawthorne and his Wife. Mr. Parkman's Montcalm and Wolfe. Johnson's Persia. A Word for Pepys. The Contributors' Club. Books of the Month.

In the *Popular Science Monthly* for February, which was received rather more promptly than usual, we find the following articles principally written especially for its columns: The Sight and Hearing of Railway Employes, by William Thomson, M. D. (Illustrated); Calculating Machines, by M. Edouard Lucas, (Illustrated); The Larger Import of Scientific Education, by J. W. Powell; Evolution and the Destiny of Man, by W. D. Le Sueur; Food and Feeding, by Grant Allen; Sulphur and its Extraction, by C. G. Warnford Lock, (Illustrated); Physical Training of Girls, by Lucy M. Hall, M. D.; Field Experiments in Agriculture, by Prof. H. P. Armsby; Cholera, I, Its Home and Its Travels, by Dr. Max von Pettenkofer; The Chemistry of Cookery, by W. Mattieu Williams; Sick-Rates and Death-Rates, by Cl. T. Campbell, M. D.; Properties and Constitution of Sea-Water, by M. Antoine de Saporta; Why Birds Sing, by Dr. B. Placzek; Sketch of Sir David Brewster, (With Portrait); Correspondence; Editor's Table: "Mind as a Social Factor"—The Relation of Science to Culture; Literary Notices; Popular Miscellany; Notes.

The Scientific Club of the Kansas Agricultural College meets monthly in the Chemical Laberatory. Professor W. A. Kellerman is President and Professor I. D. Graham Secretary. Among its other active members are Prof. Failyer, Prof. Popenoe, Prof. Shelton, Mr. M. A. Carleton, Mr. Lund, A. W. Jones, J. B. Brown, Warren Knauss, and others. From its proceedings, as published in the *Industrialist*, it is evident that this club is doing a good work for the Institution and the State.

Professor B. Silliman, one of the editors of the *American Journal of Science*, and son of its originator, died January 4, after a long and useful career as editor, professor of chemistry in Yale College, author of several text books on chemistry and natural philosophy, charter member of the National Academy of Sciences, honorary member of the principal scientific societies of Europe, etc. He was 68 years of age and was apparently still in the prime of life when he was taken away. His loss will be severely felt among scientists all over the world.

Science, now in its third volume, has had a very successful career so far, and has made a decided impression upon the scientific world as an innovator, at least in manner. It has been ably supported and has presented the new theories and discoveries of the past two years promptly and authoritatively. It is now so firmly established that it can can hardly fail to hold a leading position among the scientific periodicals of the day, either in this country or on the continent. Being, strictly speaking, the only weekly scientific journal in the country, it deserves the patronage of all readers who desire or need to keep fully up with the rapid progress of the age in science.